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AID TO TEACHERS AND STUDENTS

IN

NATURAL PHILOSOPHY;

BEING THE

"KEY"

TO

DR. JOHNSON'S PHILOSOPHICAL CHARTS;

ACCOMPANIED WITH

FACSIMILES OF THE CHARTS

ON A REDUCED SCALE.

BY

FRANK G. JOHNSON, A.M., M.D.

NEW YORK:
PUBLISHED BY A. RANNEY,
No. 195 BROADWAY.

1856.

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PREFACE.

THIS series of Charts, as a work on Natural Philosophy, is entirely *new*, and was suggested to the author from laboring under the great disadvantages experienced in attempting to teach this subject without the aid of apparatus, or any *substitute* for it, when he adopted the plan of making crude diagrams with crayon pencils on large sheets of paper, with *which*, even, he found he could fascinate his entire school of over a hundred scholars; arousing in them the liveliest interest for this study, so long reputed among them to be "*so* dry and tedious."

These charts embrace, besides several original illustrations, all the essential diagrams and drawings contained in the popular and commonly used text-books upon this branch of education; *numbering about three hundred drawings*, illustrative of all the *more important outline* principles of the natural sciences, as generally taught in schools; accompanied with the following pages, which, (designed as a key,) designate the several figures, showing what each illustrates, and, in most instances, giving in brief the *essential explanation.*

It has been the *especial aim* of the author to make each diagram as *simple* as possible, without omitting any part necessary to give a *clear* illustration of the *essential law or principle* to be explained.

The charts, which are ten in number—each being

34 by 52 inches, are well bound, and strongly mounted on cloth and rollers. They are printed with *white lines on black ground*, and most of the drawings are colored, making them *distinctly visible* from any part of the largest school-rooms; preventing them from becoming soiled, besides giving them a *neat*, *lively*, and *ornamental* appearance.

The key and charts are not intended to take the *place* of a regular text-book, but to *accompany* such; to aid the instructor in *teaching*, and the pupil in *learning* and *retaining* the principles contained in the regular text-book. The ingenious *teacher*, however, will be able to *impart*, and the *scholar* to *retain*, more instruction *with* the charts, and *without* the text-book, than *with* the text-book, without the charts.

The charts are *especially* designed to supply the wants of our common or district schools, in the *absence* of the apparatus, which they have come greatly to need, but are generally unable to purchase. In many parts of the country, the *majority* of district schools are no longer "common schools," merely; where is taught only spelling, reading, and writing, together with the primary branches, arithmetic, geography, and grammar; but they have come to be academies, where, *at least*, so much of the natural sciences are taught as is contained in the ordinary school manuals on Natural Philosophy; thus creating a *general* and ever *increasing necessity* for a work of this kind, as a *cheap* and *adequate substitute* for the philosophical apparatus.

The teacher will be able to make use of the charts in various ways. He may use the pointer himself, or have the pupil use it. A good plan is to have the scholar exercise himself, by demonstrating, with the pointer, diagrams contained in previous lessons, which he will be able to do with success and advantage, having witnessed the teacher's previous demonstrations; or the pupil may do the same with the advance lesson *before* listening to the instructor's explanation.

It is of the utmost importance that the scholar acquire the habit of oral demonstration, as it is by this practice that the teacher is enabled to know what the scholar's difficulties are—to ascertain what he *understands*, and what he *does not*, a quick appreciation of which is one of the greatest secrets of successful teaching. By frequent demonstrations, the learner, at the same time, cultivates the power of expressing and communicating to others what he has acquired. The pupil, too, should be frequently exercised in reviewing, for, to *learn* and *forget* as readily, is of but little use. Every practical teacher will appreciate the necessity of *demonstrating*, in order, also, to obtain a *definite* and *thorough* knowledge; together with the importance of *reviewing*, in order to *impress* the *idea* on the memory. *Habitual demonstrating and constant reviewing, are absolutely indispensable to the highest degree of success in the great art of teaching.* And the philosophical charts are *particularly adapted* to facilitate *both* of these exercises.

For further description of the work and its utility see INTRODUCTION.

INTRODUCTION.

There are no institutions of the age of more importance than those of common education; and of these none hold a more essential rank than the "Common Schools." It is in these institutions where the *first habits* of study are formed, and where the rudimentary and fundamental principles of knowledge and science are acquired; and every experienced teacher understands the importance of forming correct *habits* of study, and the still greater necessity of acquiring a *lucid and thorough understanding of the elementary and foundation principles*, in order to comprehend, with any degree of success, the more intricate and complicated principles of science, that constitute an endless study for all subsequent lifetime. Hence whatever promotes the success of such institutions, or facilitates the art of teaching, must be deserving of attention, and worthy the necessary means of acquisition. When the scanty supply, the almost entire absence of aids and helps, save a bundle of birch rods and a hugh oak ruler—which constituted the assistance of the teacher a few years ago—is contrasted with the many facilities with which the instructor is, or may be, surrounded at the present day, every one who has a child to be educated, a feels himself at all interested in the general education of his fellow beings, will be at once pleased and surprised to behold how great and rapid has been the improvement achieved in this important question of educational progress.

Among the many means which, for the past few years, have been brought to aid in this most essential art of life, that of teaching, the most serviceable and popular is that of *representing* to the *eye*, what before was only *demonstrated* to the *ear*.

How limited would be our knowledge of Language, Geometry, Algebra, and Arithmetic, for instance, without their *visible* symbols? And with them how great is our progress in these branches, and how extensive is their application in the development of other sciences, and the useful pursuits of life. Imagine the slow and tedious process of teaching Mathematics to a young mind through the *ear*, without representing the same to the *eye* by means of *figures*, *letters*, and *diagrams*. But by these symbols, with slate and black-board, he gives to these *invisible*, and, as it were, *imaginary* things, *dimensions*, *localities* and *names*, so that he may be able to *see* them, and seeing, *grasp* them, while the mind's eye contemplates them at *leisure*. Music could not rise to the dignity of a regular art, until musical notes were invented, which rendered it possible to express harmonies of sound to the *eye*. If the mind may be so greatly aided by ocular signs, when there is no natural relation between them and the objects they represent, as in letters, numerals, figures, and musical notes, how much more must its power be increased, when the symbols and drawings assume the pictorial character, and become, in a manner, *actual imitations* of the things to be considered?

Visible diagrams are most useful where definite and exact properties and relations are to be communicated to the mind, as in natural science.

Whenever the object consists of such fixed elements and qualites as are capable of delineation, but are not themselves tangible, pictorial illustrations of some kind become indispensable, as in Geometry, Trignometry and other higher mathematics. In communicating descriptions of physical objects, which, in their extent and complexity, are beyond the scope of *direct* vision, as in Geography, Geology and Astronomy, illustrations and delineations are *aboslutely* indispensable. With what success could Geography be taught or comprehended by written and oral description without the aid of *maps?* A mere *glance*, however, of the *eye*, at geographical *maps* and astronomical *charts*, will give a more correct appreciation of the *position* and *magnitude* of oceans, continents, rivers, mountains, states, countries and towns, also of suns, planets, comets, and stars, than it were possible to obtain by reading *volumes* of *written* description. A person, for instance, shall spend only *one hour* in viewing a well-executed *panorama* of the Mississippi river and its scenery, and thus obtain a more *correct* and *lasting* impression of the same, than by perusing an elaborate and well-written description for *weeks* and *months*. An entire volume, and a course of lectures descriptive of a large city, would fail to equal *one* good *cosmoramic* view, requiring but *five minutes'* contemplation.

It would seem impossible in these times to acquire a respectable knowledge of Anatomy, Physiology, and Surgery, without the aid of the numberless and elaborate illustrations thickly interspersed throughout every recent book on these subjects.

The study of history, too, is very greatly facilitated by charts and diagrams. The study of Natural History would be *impossible* without the assistance of pictorial representations; but with the help of these, a speci men of every class, species, and variety of man, beast bird, fish, reptile, and insect, *from every quarter of the globe*, can be brought into the study or school room to be contemplated by the learner at his leisure.

When objects to be considered are too *minute* to admit of immediate observance, or in their nature are wholly *invisible*, invaluable assistance is rendered by pictorial descriptions, as in microscopic science and chemistry. An extensive system of diagramizing is yet to be applied to chemical science; but heretofore, in this branch of study, beyond the use of letters and numerical figures, there has been, for common use, at least, no systematic plan of visible illustration, save an excellent work produced by Edward L. Youmans, in which the simpler compounds and the primary and more important principles of Chemistry are *most beautifully* and *instructively* pictured.

Again, in the Mechanic Arts and Architecture, how important is the aid derived by means of delineations. Suppose it were attempted to give a full description of a modern steam engine, or a watch, or a complicated printing-press, by addressing the imagination and perceptive faculties orally, without any kind of illustrative diagrams, and a *hundred days*, and as *many* volumes would be required, to impart little more than a vague idea of these objects; on the other hand, a mere *glance* of the *eye*, at the diagrams and pictorial illustrations of these complicated machines, will enable even younger minds to obtain quite a clear understanding of their construction and operation.

Moral sentiments, too, can not possibly by any *other* method be half so immovably impressed upon the mind as by means of pictures. Henry Ward Beecher says he used to look at the picture of the "Boy stealing apples" till he fairly wore out that leaf of his spelling-book. This is the experience of *all*. There is hardly a child but will read "Esop's Fables" *with the pictures*, while, on the other hand, hardly a child would read the same fables *without* them. Grown persons as well as children, will have their attention excited when *real* objects are brought before them; and in the absence of real objects, good pictures will interest them equally; and this is for the reason that their *understanding* is so much *aided by them* as to receive *gratification*, and yield the *ready* pleasure of KNOWING. But in oral and written descriptions alone, the *mental effort* required to *comprehend* overpowers *curiosity*, which renders it a task to give attention, and thus destroys the pleasure of study. In conversation on common subjects, even, do we not almost *instinctively* catch up pen or pencil, and represent to the *eye* what we are attempting to describe to the *ear*? And this is because we can make ourselves so much more *easily* and *distinctly* apprehended.

Books, which but few years ago were made in solid pages of reading matter, presenting a dull monotonous appearance, are *now* relieved and enlivened with a thousand interesting illustrations—each page inviting the learner, and claiming his attention, with some lucid and instructive picture. Many subjects which before were considered dry and uninteresting, and even beyond the capacity of ordinary minds, and therefore seldom pursued by them, or if so, with an obscureness that amounted to a waste of time, have now come to be so clearly explained, by means of this picture-making art, as to be brought within the comprehension of the most ordinary minds; thus causing the natural sciences, especially, to be more generally read and appreciated than were possible by any other method.

The superiority of the *eye* over all other senses, as a means of education, is undeniable, for it has been demonstrated beyond a question. No other system of teaching renders the aquisition of knowledge—especially scientific knowledge—so *pleasant* and *agreeable* to the learner. With appropriate diagrams and drawings, properly demonstrated, scholars will become *fascinated* in studying those principles and sciences which before they *dreaded*, and pronounced *tedious* and *irksome*, and tried their utmost to *avoid*. This method not only makes study a *pleasure*, both to teacher and pupil, but it greatly economizes their *time* and *labor*, and produces in the learner the habit of *demonstrating*, giving the acquired knowledge of general principles an *exactness* and *fixedness* in the mind, which enables him, in after life, to make a ready and practical application of his education.

In short, Authors, Lecturers, and Teachers, in almost every branch of learning, have found, by the *infallible test* of *experience*, that they may POUR knowledge, in large measures, through the *eye*, and impress it *indelibly* on the mind. Otherwise why have books on all subjects come to be so filled up with pictures? There is hardly a work now, on the natural sciences, at least, but what contains hundreds of illustrations. Pictures are no longer made *solely* for the amusement of *children*. Books treating of the *most intricate sciences*, even, have come to be *emphatically* "Picture Books."

Already may many books be *read* by their pictures. *Less reading matter* and *more pictures*, is fast becoming the motto in book-making.

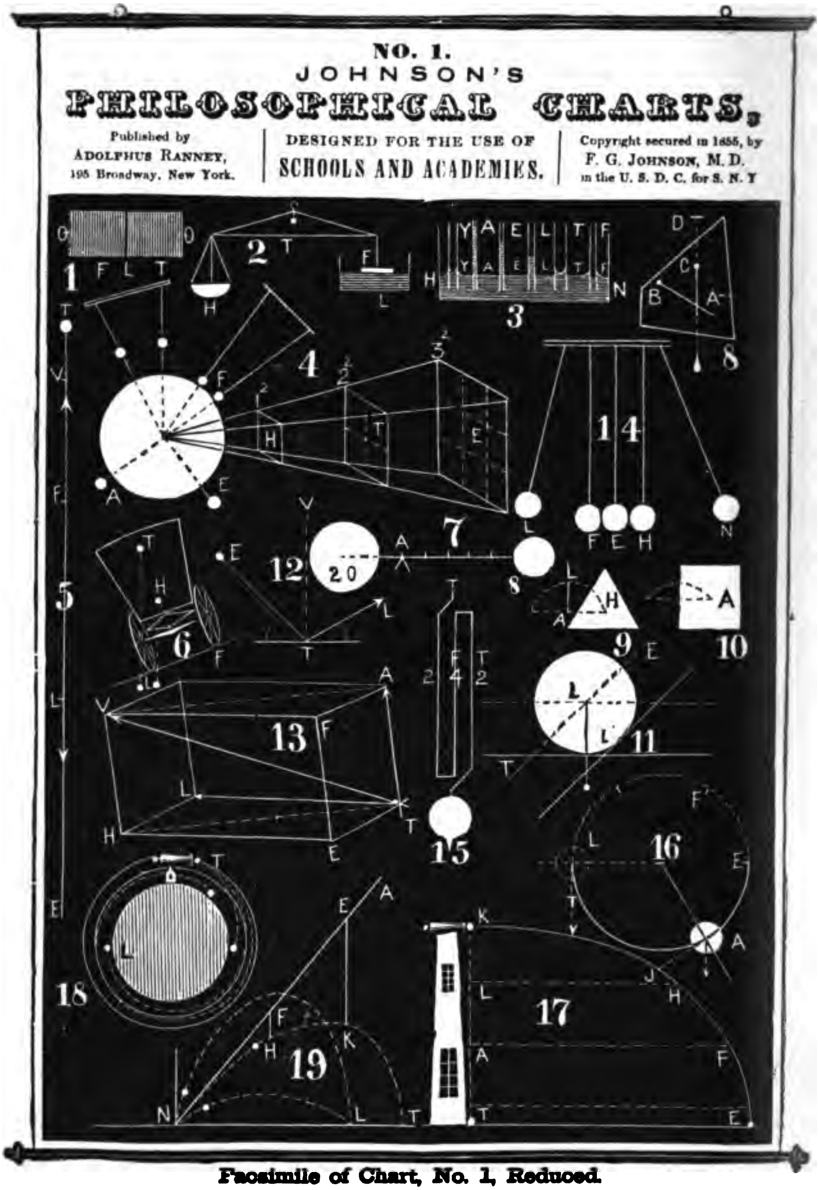
Of the various *methods* of pictorial illustrations, that of maps and charts, on a large scale, for the use of teachers and lecturers, is the most serviceable, as it enables the instructor to make his demonstrations to a whole class, school, or public audience of thousands, even, with the same time and effort required to give the same explanation to one learner alone. Especially useful and necessary are such maps and charts in common schools and academies, where the *learners* are *beginners*, and consequently their powers of abstraction as yet undeveloped. Even the "A, B, C's" and "a-b ab's," addition and multiplication tables, &c., are now extensively printed in the form of charts, and at once placed before the whole school or class, and are thus taught with a *hundred fold greater success* than by the old method of calling up one youngster at a time and pointing with a pin at a dozen small, obscure, half-obliterated letters, and telling him *that* is A, *that* is B, *that* is C, &c., then, shutting the book, send him to fold his hands for the next two or three hours, to gaze at nothing but the *blank walls.* If the assistance rendered by charts be so great in teaching these mere *symbols* and *simplest rudiments*, how much greater must be their utility in teaching those *general principles* which constitute the basis of several *important sciences*, as in the study of Natural Philosophy.

Natural Philosophy, as treated in school-books, being composed of a description of the *fundamental* and *leading principles* of several separate sciences, as Mechanics, Acoustics, Optics, Electricity, Astronomy, &c., becomes, therefore, the common branch of education most *generally pursued* by scholars after acquiring a degree of proficiency in the more purely rudimentary branches. Natural Philosophy, too, being of an *abstract* nature, especially to *beginners* and *young* minds, it is of the greatest necessity that its leading principles be represented to the *eye* of the learner, in the most lucid and simplest form possible, that he may receive a *clear*, *strong*, and *lasting* impression of the important and foundation principles that make up this most essential branch of common education. Natural Philosophy is so almost universally applicable, in one or another form, to the useful pursuits of life, that *every scholar* should pursue it and engraft its principles deep in his mind, before he set out on his practical life in earnest. If any one study is to be more thoroughly *demonstrated* and *mastered* than another, it should be *this*. But it is the opinion of *all* teachers, that without the aid of appropriate *apparatus*, or *drawings*, Natural Philosophy, *especially*, can be taught with but little success. To draw the necessary diagrams on the black-board, from day to day, requires too much of the teacher's *time*, and so much of his *patience* and *skill* that he seldom draws them at all; and, if he *draw* them, they are erased from the board the next half hour; and to obtain the *real*, necessary philosophical apparatus, is too *expensive* to be generally afforded. Of common schools and academies, hardly one in a thousand can afford the apparatus. Many thousand dollars would be required to purchase all the apparatus represented by these charts; yet *these* will serve all the *general purposes* of a complete apparatus, and in some respects *answer better*, and are not so expensive but that *every* school may obtain them. Once in the school-room, they are constantly before the learner, and at the command of the instructor, instead of being *locked up* and *out of sight*, as is usually the case with the apparatus. The charts, too, can be seen at greater distance, and by greater numbers at a time. Besides, many things are well delineated by the charts that could not be shown at all in the school-room, with the apparatus.

FRANK G. JOHNSON.

Brooklyn, N. Y.

NOTE.—The designating numbers, in some instances, do not occur in their natural order. As it was designated subsequently to accompany the charts with a key, the diagrams were not engraved with reference to numbering; consequently the numbers were arranged with reference to convenience rather than order.



NO. 1.

JOHNSON'S

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Facsimile of Chart, No. 1, Reduced.

CHART NO. ONE.

FIGURE 1.

Two blocks of lead, joined at L by very flat and smooth surfaces, to illustrate *atmospheric pressure* and *cohesive attraction*.

FIG. 2.

Illustrates the same principles as Fig. 1.—L a basin of water and F a flat piece of board or metal.

FIG. 3.

Illustrates *capillary attraction*. HN, a dish of water; Y, A, E, L, T, glass tubes; F, a glass bar. The water is shown as being attracted upward by the sur face of the tubes and bar.

FIG. 4.

Illustrates *attraction of gravitation*. The lines drawn to the center of the earth show the *direction* in which the force of gravitation acts. The long lines and parallelograms represent the *diminution* of the force of gravity to be equal to the *increase* of the square of the distance from the center of the earth.

FIG. 5.

Represents the velocity of rising and falling bodies at different times and distances from the earth, when projected in a vertical direction.

Fig's 6, 7, 8, 9, 10.

Illustrate the phenomena relative to the *center of gravity* of bodies. The centers of *gravity* and *inertia* of bodies are always at the same point.

A body which is at rest, in order to be overturned, must have its center of gravity elevated; hence the stability of a body will be in proportion to the amount of this elevation; therefore a pyramid (Fig. 9) will rest more firmly than a cube (Fig. 10.) It is for this reason, too, that a sphere (Fig. 11) is so easily overturned.

Fig. 11.

Shows why a wheel or globe will roll down an inclined plane; *viz.*, its center of gravity not being sustained.

Fig. 12.

Is to illustrate *reflected motion.*

Fig. 13.

Shows the *resultant motion* of a body, when moved by several forces, acting in different degrees and directions. Thus a body T, acted upon by a force in the direction of and equal to TL, will pass to L. If another force be simultaneously applied in the direction of and equal to TE, then will the body pass over the diagonal line TH to H. If a third force, equal to and in the direction of TA, be applied, the body will pass over the line TV to V. The resultant of these three forces is the same as that of the two forces TH and TA.

FIG. 14.

A set of ivory balls, to illustrate the principles of *action and reaction* of moving bodies.

FIG. 15.

The *gridiron pendulum rod*, used to counteract the effects of variations of temperature. The rod F being made of metal which expands and contracts, by variations of temperature, twice as much as the iron rods L and T, the distance from the suspension point to the pendulum will remain the same at all temperatures.—2 × 2=4.

FIG. 16.

Represents the forces and principles of action of the pendulum.

FIG. 17.

Illustrates *curvilinear motion*, which is produced by the action of two forces, *viz.*, *projectile force* of the gun, and *gravitation.* This figure shows that a ball, K, shot from the gun will reach the ground at E, in the same time that another would at T, should it be *dropped* from the gun's mouth at the same instant.

FIG. 18.

Represents the shooting of a cannon ball around the earth above the atmosphere.

FIG. 19.

Represents the track of a cannon ball as projected at different angles of elevation; the middle one being set at an angle of 45°, one of the other two is as much above 45° as the other is below. At an angle of 45° the ball will pass over the greatest possible horizontal distance, with a given amount of projectile force.

CHART NO. TWO.

Fig. 1.

Lever of the *first kind*, divided into ten equal spaces. V, the fulcrum; W, the weight, (or resistance;) P, power; 8, the long arm; 2, short arm; long arm × P. = short arm × W., or $8\times 6=2\times 24$. Hence, to find either arm, P. or W., we have

$$\frac{\text{long arm}\times\text{P.}}{\text{short arm}}=\text{W., or}\ \frac{8\times 6}{2}=24;$$

$$\frac{\text{long arm}\times\text{P.}}{\text{W.}}=\text{short arm, or}\ \frac{8\times 6}{24}=2;$$

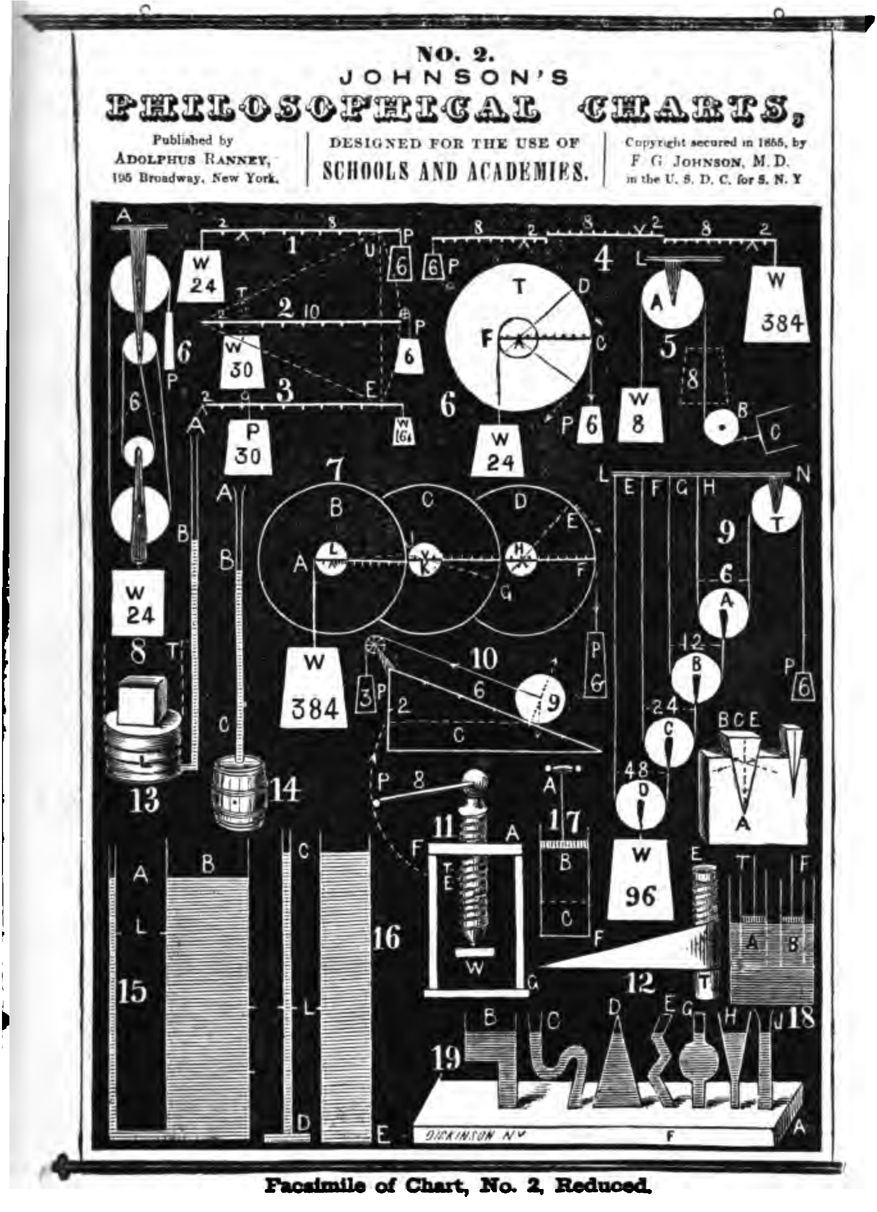
$$\frac{\text{short arm}\times\text{W.}}{\text{long arm}}=\text{P., or}\ \frac{2\times 24}{8}=6;$$

$$\frac{\text{short arm}\times\text{W.}}{\text{P.}}=\text{long arm, or}\ \frac{2\times 24}{6}=8.$$

These formulas apply to each of the other simple levers.

Fig. 2.

Lever of the *second kind*, divided into ten equal



NO. 2.
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Facsimile of Chart, No. 2, Reduced.

spaces. V, fulcrum; W, weight; P, Power; 2, short arm; 10, the long arm. ($10\times 6=2\times 30.$)

The vertical dotted lines U E and T, show the ratio or *relative distances* through which the weight and power pass; which ratio or relation is always the same as that existing between the *weight* and *power.*

FIG. 3.

Lever of the *third kind*, divided into ten equal spaces. V, fulcrum; W, weight; P, power; 2, short arm; 10, long arm. ($2\times 30=10\times 6.$)

Here the power works on the short arm; hence advantage is *lost* instead of *gained.*

FIG. 4.

Compound lever, which consists of two or more simple levers acting on each other. Here are three, each being divided into ten equal spaces.

$$\frac{\text{P.}\times\text{long arm}}{\text{short arm}}=\text{1st W. and}$$

$$\frac{\text{1st W.}\times\text{2d long arm}}{\text{2d short arm}}=\text{2d W., and}$$

$$\frac{\text{2d W.}\times\text{3d long arm}}{\text{3d short arm}}=\text{3d W., and so on.}$$

$$\text{Hence }\frac{6\times 8}{2}=24\text{, and }\frac{24\times 8}{2}=96\text{, and }\frac{96\times 8}{2}=384.$$

FIG. 6.

Wheel and axle, which is a constantly acting simple lever. F C, a line divided into ten equal spaces, *eight* of which constitute the diameter of the wheel and the other *two* the diameter of the axle. W, weight; P, power. Semi diam. wheel × P. = semi diam. axle × W., or 8 × 6 = 2 × 24. Hence, to find the P., W., or semi diam. of wheel or axle, we have

$$\frac{\text{semi diam. wheel} \times \text{P.}}{\text{semi diam. axle}} = \text{W., or } \frac{8 \times 6}{2} = 24;$$

$$\frac{\text{semi diam. wheel} \times \text{P.}}{\text{W.}} = \text{semi diam. axle, or } \frac{8 \times 6}{24} = 2;$$

$$\frac{\text{semi diam. axle} \times \text{W.}}{\text{semi diam. wheel}} = \text{P., or } \frac{2 \times 24}{8} = 6;$$

$$\frac{\text{semi diam. axle} \times \text{W.}}{\text{P.}} = \text{semi diam. wheel, or } \frac{2 \times 24}{6} = 8.$$

Fig. 7.

Compound wheel and axle, which is a constantly acting compound lever. (The teacher will readily perceive the mode of action of this machine by reference to the compound lever, the weight, power, and length of levers being the same.)

$$\frac{\text{P.} \times \text{semi diam. wheel}}{\text{semi diam. axle}} = \text{1st W., and}$$

$$\frac{\text{1st W.} \times \text{semi diam. 2d wheel}}{\text{semi diam. 2d axle}} = \text{2d W., and}$$

$$\frac{\text{2d W.} \times \text{semi diam. 3d wheel}}{\text{semi diam. 3d axle}} = \text{3d W. and so on.}$$

Hence $\frac{6\times 8}{2}=24$, and $\frac{24\times 8}{2}=96$, and $\frac{96\times 8}{2}=384$.

FIG. 5.

A, a simple, immovable pulley; L, beam; W, weight; B, friction wheel. The dotted lines show that the weight and power are equal.

FIG. 8.

Compound pulley. The P., 6, being multiplied by the number of cords, gives the W., and conversely.

$\text{P.}\times\text{num. cords}=\text{W.}$, or $6\times 4=24$;

$\frac{\text{W.}}{\text{P.}}=\text{num. cords}$, or $\frac{24}{6}=4$;

$\frac{\text{W.}}{\text{num. cords}}=\text{P.}$, or $\frac{24}{4}=6$.

FIG. 9.

A system of pulleys. N, a fixed beam; F, an immovable pulley; A, B, C, D, movable pulleys; P, power; W, weight. W., (96,) being divided by 2, as many times as there are movable pulleys, gives the P. (6;) and *vice versa.*

$\frac{96}{2}=48$, $\frac{48}{2}=24$, $\frac{24}{2}=12$, $\frac{12}{2}=6$.

$6\times 2=12$, $12\times 2=24$, $24\times 2=48$, $48\times 2=96$.

FIG. 10.

Inclined plane. W, weight; P, power; C, the base; 2, the perpendicular, and 6, the plane, are divided into equal spaces. The relation between the length of the plane and perpendicular is the same as that between the weight and power; or P. × leng. plane = W. × perpendicular.

Hence,

$$\frac{\text{P.} \times \text{leng. plane}}{\text{perpendicular}} = \text{W., or } \frac{3 \times 6}{2} = 9;$$

$$\frac{\text{P.} \times \text{leng. plane}}{\text{W.}} = \text{perpendicular, or } \frac{3 \times 6}{9} = 2;$$

$$\frac{\text{W.} \times \text{perpendicular}}{\text{leng. plane}} = \text{P., or } \frac{9 \times 2}{6} = 3;$$

$$\frac{\text{W.} \times \text{perpendicular}}{\text{P.}} = \text{leng. plane, or } \frac{9 \times 2}{3} = 6.$$

The *Wedge* is another form of the inclined plane, (seen under Fig. 9.) The dotted lines show the direction in which the forces act.

Fig. 11.

The *Screw*, which is still another form of the inclined plane. P, power; 8, lever; TE, distance between the threads; W, weight. The circumference of the circle described by the lever, multiplied by the power, equals distance between threads multiplied by the weight; or Cir. circle by lever × P. = dis. between threads × W.

Hence,

$$\frac{\text{cir. circle lever} \times \text{P.}}{\text{dis. of threads}} = \text{W., or}$$

$$\frac{\text{cir. circle lever} \times \text{P.}}{\text{W.}} = \text{dis. of threads, or}$$

$$\frac{\text{dis. of threads} \times \text{W.}}{\text{cir. circle lever}} = \text{P., or}$$

$$\frac{\text{dis. of threads} \times \text{W.}}{\text{P.}} = \text{cir. circle lever.}$$

FIG. 12.

Shows the relation between the screw and inclined plane.

FIG. 18.

Is to illustrate the fact that liquids transmit force or pressure equally in all directions.

FIG. 19.

Is to show that the surface of fluids seeks a level; FA being a vessel filled with some fluid which communicates with the tubes B, C, D, E, G, H, J.

FIG. 15.

Shows that a *small* column of water will sustain a *large* column of equal height.

FIG. 16.

Is to illustrate the fact that the pressure of fluids upon the base of vessels is equal to the area of the *base multiplied by the height*, regardless of the *size* of the column.

It is upon this principle that a barrel (Fig. 14) can be burst with a very small quantity of water.

Another illustration of this principle is seen in the *hydrostatic bellows* (Fig. 13.)

CHART NO. THREE.

Fig. 1.

A bent tube, containing mercury and water, to show their relative weight.

Fig. 2.

Hydrometer, an instrument for ascertaining the specific gravity of fluids.

Fig. 3.

Spirit level. The dotted lines show that one end has been raised, and that the air bubble has passed to the elevated end.

Fig. 4.

The *water level*, in which the dotted lines show that one end has been elevated, while the *sights* (the dotted lines) *remain* on the same level with each other.

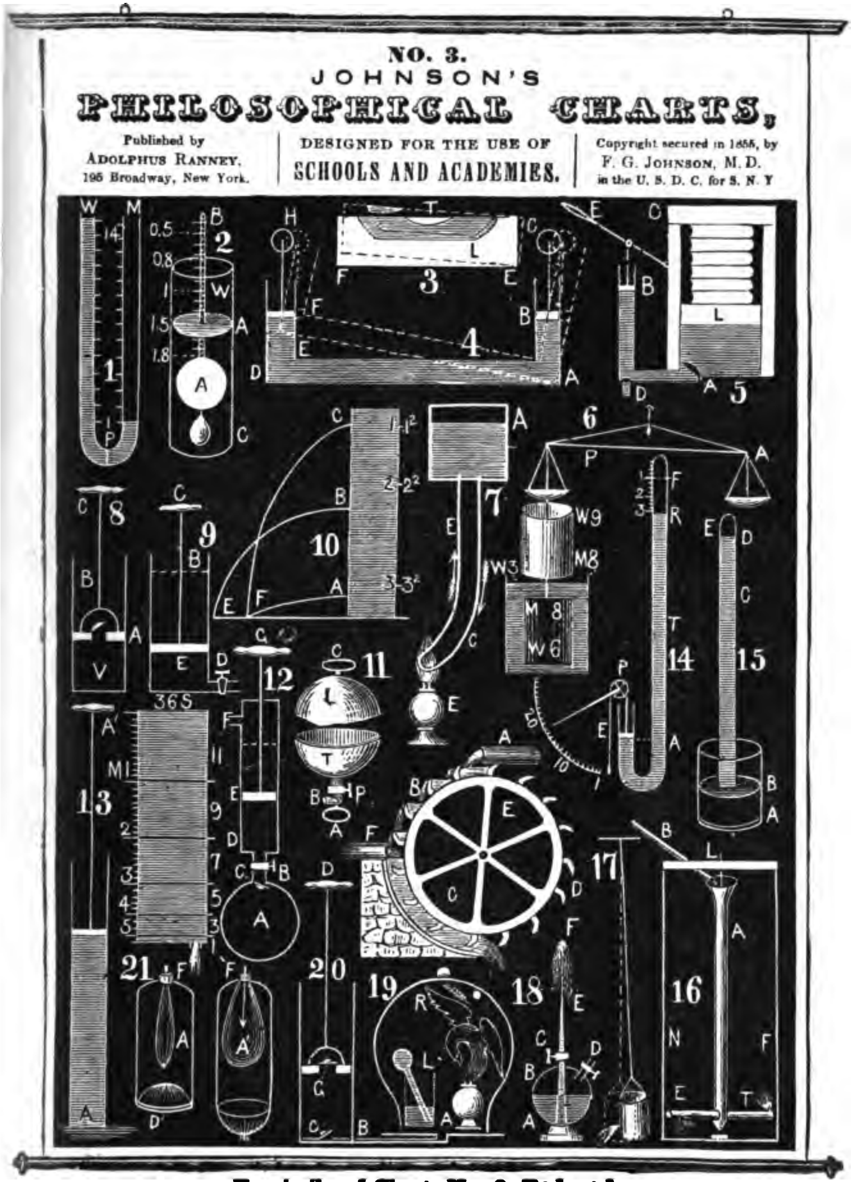
Fig. 5.

The *hydraulic press.* $P. \times \text{area large cyl.} = W. \times \text{area small cyl.}$

$$\text{Hence, } \frac{P. \times \text{area large cyl.}}{\text{area small cyl.}} = W.;$$

$$\frac{P. \times \text{area large cyl.}}{W.} = \text{area small cyl.}$$

$$\frac{W. \times \text{area small cyl.}}{\text{area large cyl.}} = P.;$$



NO. 3.

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$$\frac{\text{W.} \times \text{area small cyl.}}{\text{P.}} = \text{area large cyl.}$$

The power in these formulas is supposed to be applied without the intervention of the pump lever.

Fig. 6.

Illustrates the mode of finding the *specific gravity of solids*. The body here weighs *out* of water 9 lbs., *in* water 6 lbs., which shows a *loss* of 3 lbs. This *loss* expresses the weight of water which in *bulk* is just equal to the block. Now, as the block weighs 9 lbs. and an equal bulk of water 3 lbs., it follows, that the block is as much heavier than water as 9 is greater than 3, which is *three times* greater; and as water is taken for the unit, the specific gravity of the block is 3. *Rule*—Divide the weight *out* of water by *loss* of weight *in* water. If weight is needed to sink the body, it must be added to the *loss*. M stands for measurement.

Fig. 7.

Shows that water, when heated, expands and thus becoming specifically lighter, rises to the surface.

Fig. 10.

Shows that the amount of water which will be discharged from a vessel through similar apertures, at different distances from the top, will be in proportion to the square of the distances of the apertures from the top. The jet situated midway from the top to bottom will pass over the greatest horizontal distance.

Figure to the right of Fig. 13 represents a vessel of uniform capacity, filled with water. If an aperture be made in the bottom, the amount of water discharged at different successive times (minutes) will vary as the numbers 9, 7, 5, &c. Here the vessel is divided into 36 equal spaces, and during the *first* minute, (or period of time,) 11 of these spaces will be emptied; during the *second*, 9; during the *third*, 7, &c.

FIG. 17.

(On the left.) *Water-wheel.* When the water passes on at A, it is termed an *overshot wheel;* when at F, a *breast wheel.* When the water runs directly under the wheel, (not shown here,) it is called an *undershot wheel.*

FIG. 17.

(On the right.) Is a suspended bucket of water, with an aperture in the side, to show the force of re-action of a jet of water. The dotted lines show where the bucket *would* be were there no jet.

FIG. 16.

Barker's mill, which operates by force of re-action of jets.

FIG'S. 8 & 9.

Are cylinders with pistons fitted air-tight, to illustrate the compressibility, elasticity, and weight of the atmosphere.

FIG. 11.

Two hollow hemispheres, made to fit each other air-tight, to show the atmospheric pressure, by pumping the air from the interior.

FIG. 12.

Condenser, for compressing the atmosphere.

Fig. 13.

Piston, piston-rod, and cylinder. When the piston is drawn up, a vacuum is made and the water is urged on to fill it by the pressure of the air on the surface of the water at A. It is by this principle that water is forced up the common pump.

Fig's. 14 & 15.

Barometers. Fig. 14, a *wheel barometer.*

Fig. 18.

A fountain which operates by the force of the elasticity of condensed atmosphere.

Fig's. 19 & 20.

Receiver and Air-pump. The *lamp* indicates that where there is no air there is no combustion; the *bird*, that without air there is no *flight* or *animal life.* As the air is pumped out, its pressure is taken off the water in the basin; hence the water in the flask falls down. The ball and feather indicate that where there is no air, light and heavy bodies will fall by force of gravity with equal rapidity.

Fig. 21.

Is to illustrate the process of *animal respiration.* A and A′ are two sacks or bladders situated in glass jars and communicating with the external air. D and D′ are leather caps. Now, if D be drawn down, a partial vacuum will be formed and external air will rush in at F and distend the sack A. This is equivalent to *inspiration.* If D′ be forced up, the air in A′ will be crowded out. This is *expiration.* The two jars take the place of the *chest;* D, D′, the *dia* *phragm;* A, A′, the *lungs;* apertures F, F′, the *mouth.* The motion of the *ribs* aids this process.

CHART NO. FOUR.

Fig. 1.

Siphon. To show that the siphon operates by atmospheric pressure on the water in the basin, turn the faucet F, and it will cease to operate at once.

Fig. 2.

Suction and Lifting Pump.

Fig. 3.

Rotary suction and forcing pump. As the cog wheels are turned the water *above* them is urged along; while *below,* a vacuum is produced, which brings the water from the cistern.

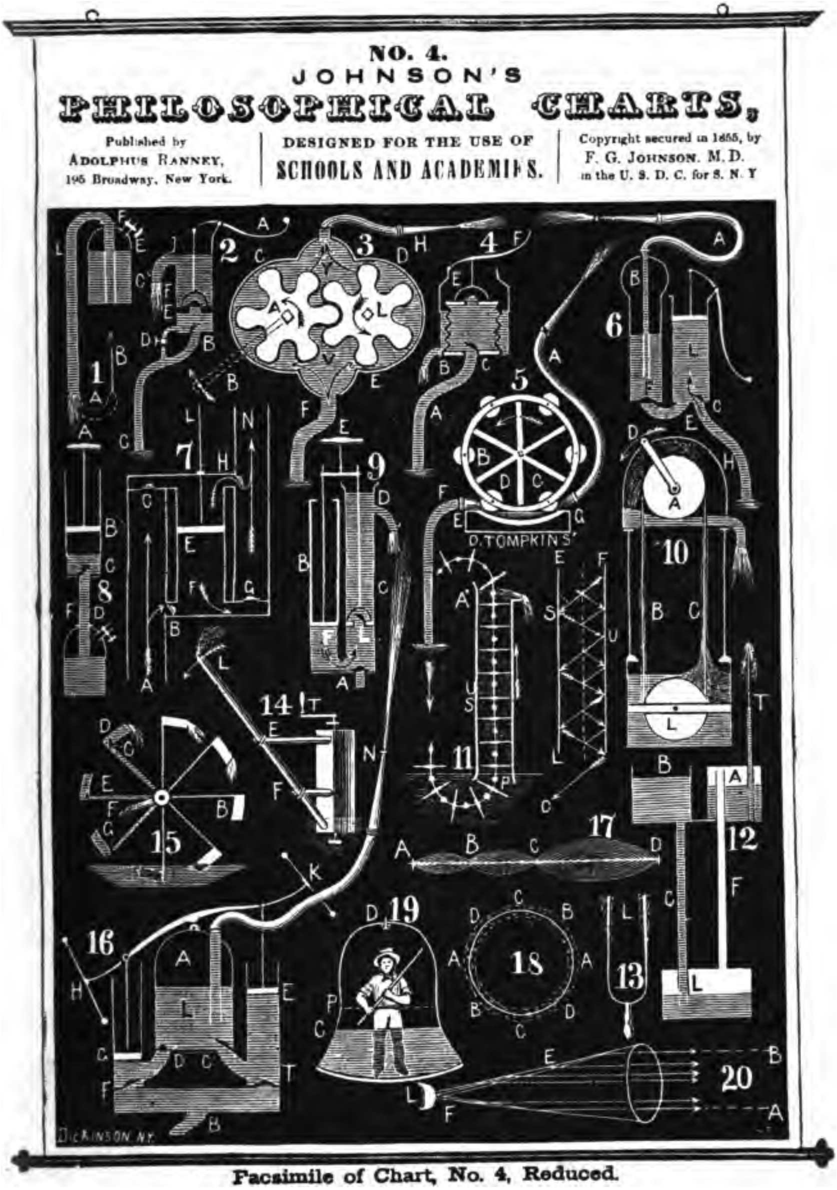
Fig. 4.

Suction bellows pump, working without friction. The vacuum is produced by lifting the upper plate of the bellows.

Tompkins' rotary suction and forcing rubber pump. The rollers pass over an elastic rubber tube, urging the water along, and as the pipe springs back to its tubular shape, the vacuum is produced.

Fig. 6.

Common suction and forcing pump, provided with an air-chamber.



NO. 4.

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Facsimile of Chart, No. 4, Reduced.

Fig. 7.

Double acting suction and forcing pump.

Fig. 8.

Is to show that suction pumps will not operate unless the air is allowed to press upon the surface of the water. Turn the faucet D, and the water ceases to follow the piston B, at once, and a vacuum is produced. If the faucet D is now opened again, the water will rush up to fill the vacuum.

Fig. 9.

Suction pump, with two cylinders so arranged as to produce the flow of a constant stream.

Fig. 10.

The rope machine.

Fig. 11.

The chain pump—not represented entire, but sufficiently so to illustrate its operation.

Fig. 12.

Hero's fountain.

Fig. 14.

Centrifugal pump.

Fig. 15.

Wheel pump. By means of valves, this pump may be made to discharge through the arms at the center of the wheel.

Fig. 16.

Fire engine, which is no more than a *double suction force pump*, provided with a common *air chamber*, A.

Fig. 19.

Diving bell. In *this* bell the man is supposed to be standing on the ground.

Fig. 13.

A turning fork, showing the vibrations which put the air in motion.

Fig. 17.

Shows the *vibrations* of a musical cord.

Fig. 18.

Represents the rim of a bell. The plain line shows its shape when at *rest;* the dotted lines show that when it is beaten, it changes from a *circular* to an *elliptical* form.

Fig. 20.

Speaking trumpet. The pointed lines show the direction of the vibrations; hence to hear the words distinctly, it is necessary to stand within the range of BA.

Fig. 10.

(On the left.) Is to illustrate *reverberated sound*, the *laws of reflected sound*, and the *variations of tone.*

CHART NO. FIVE.

Fig. 1.

Hearing trumpet, which collects the vibrations of air and reflects them to a point which is adjusted to the tympanum or drum of the ear.

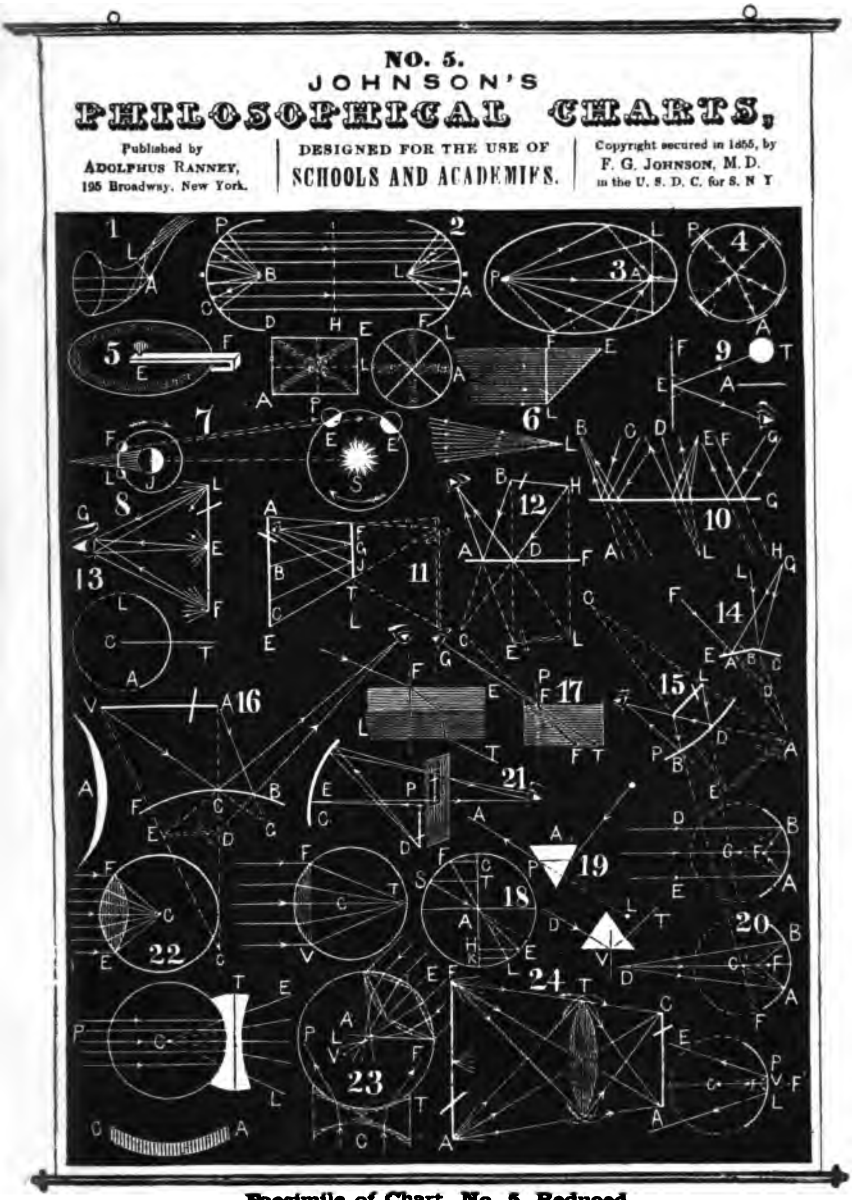

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FIG. 2.

Represents two smooth concave surfaces of equal radii, to illustrate the phenomena of *radiated*, *reflected*, and *collected* (or converged) rays of *light*, *heat*, and *sound*. B and L, the foci. Light, heat, and vibrations of air emanating from B will converge at L.

FIG. 3.

An *elliptical* surface. *Light*, *heat*, and *sound* emanating at P, one of the *foci*, will collect at A, the other *focus*.

FIG. 4.

Globular surface. Light, heat, and sound emanating at the *center*, will be reflected back to the center again.

Light, heat, and vibrations of air, have their angles of incidence and reflection equal.

FIG. 5.

(And the two figures to the right,) are plates of glass, (elliptical, rectangular, and circular,) with sand sprinkled on them, to show the phenomena of vibrations caused by drawing a fiddle-bow across their edges.

FIG. 6.

(Below.) *Converging* and *diverging* rays of light. If they pass from A to L, they converge; if from L to A, they diverge.

The *intensity* of light *diminishes* as the square of the distance from the illuminating body *increases*. (See Fig. 4, Chart No. 1.)

FIG. 6.

(Above.) Shows that light when it falls perpendicularly on a surface, is more intense than when it falls obliquely. LF receives as much light as LE, but LE is greater than LF.

FIG. 7.

Illustrates the process of ascertaining the *velocity of light*, by reference to the moons of Jupiter. S, the sun; E and E′, the earth in its orbit; J, Jupiter; L, F, one of Jupiter's moons in its orbit. As the moon L passes to F, its light will be intercepted at the earth as *much longer* than the *real* time required for this passage of the moon from L to F, as it will take the light to travel from E to E′. Hence, knowing the amount of prolongation of this interception (fifteen seconds) and the distance from E to E′, (2,880,000 miles,) it is easy to calculate the velocity of light. 2,880 000 ÷ 15 = 192,000 miles per second.

FIG. 8.

Shows that every point of an object emits an indefinite number of rays, more or less of which enter the eye to form an image or picture of the same upon the retina.

FIG. 9.

Illustrates how an object may be seen by means of a mirror, (TE,) though there be an opaque canvas (A) intercepting the eye and object.

FIG. 10.

Shows the effects of a plain (flat) mirror upon rays of light. *Parallel* rays are *reflected parallel;* *converging*, equally *converging; diverging*, equally *diverging.*

FIG. 11.

Shows how a person or object may be seen or reflected *entire* by a plain mirror of *half* its own length.

FIG. 12.

Shows the relation of the *image* to the *object* as seen in or by a plain mirror. Also illustrates how the *image* seems to be as far *behind*, as the *object* actually is in *front* of the mirror.

FIG. 13.

Is a *concave* or *convex* mirror, according to the side used.

FIG. 14.

Convex mirror, in the form of very short *plain* mirrors, the better to show its effects upon rays of light. By the *convex* mirror, divergent rays are *reflected more* divergent, &c., &c.; so that the *reflected* rays meet behind the mirror *less* distant from it than they otherwise would. The *concave* mirror has an *opposite* effect.

FIG. 15.

Represents the relation between the *object* and its *image*, as viewed in or by a *concave* mirror.

FIG. 16.

Represents the relation between the *object* and *image*, as viewed in or by a *convex* mirror

FIG. 17.

(On the left.) Shows the effect of transparent media of different destiny, to *refract* a ray of light as it is transmitted through them.

FIG. 17.

A basin of water containing a piece of money, to illustrate refraction of light.

FIG. 18.

Illustrates the law of refraction, that the *ratio* of the sine of the angle of *incidence* to the sine of the angle of refraction, is *constant.*

FIG. 19.

(On the left.) Shows *a ray of light* refracted by a triangular prism or lens of glass.

FIG. 19.

(Below.) Illustrates *total reflection.* When the line DV, with the base of the prism, makes an angle *less than* 48° 12′, all the light is reflected up from the base towards T.

FIG. 20.

With those above and below, illustrates various phenomena respecting concave mirrors in reference to the different *foci,* and the different *situations* of the object as referred to these foci, &c.

FIG. 21.

Represents a way of practicing *beautiful illusions* by means of a large concave mirror; an explanation of which may be found in almost any Natural Philosophy.

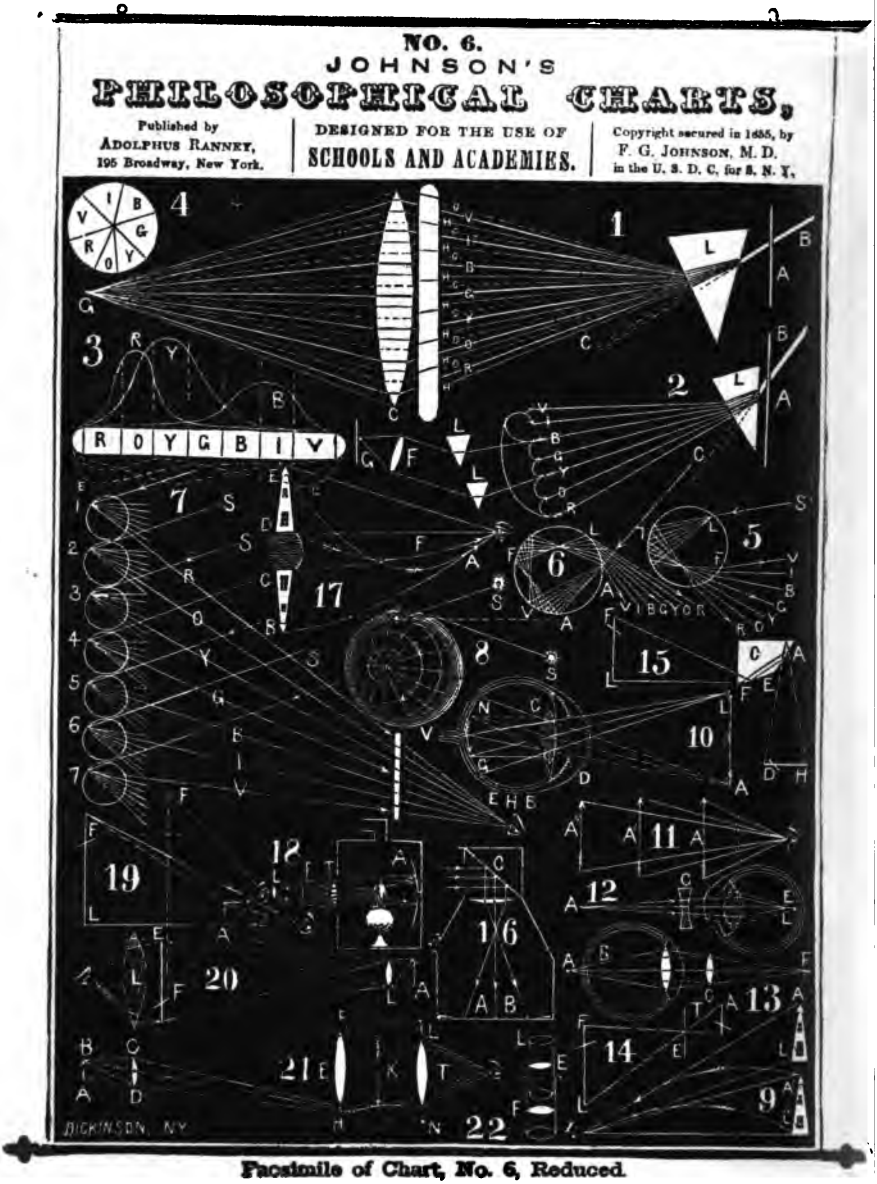

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Fig. 22.

Shows the effects of the double-convex lens upon rays of light.

Fig. 22.

(On the right.) Shows the effects of the *plano-convex* lens upon rays of light.

Fig. 23.

(On the left.) Shows the influence of the *double-concave* lens upon rays of light.

Fig. 23.

Shows that the *double-convex* lens has the same effect on rays of light as two prisms with their *backs* turned together; and that the *double-concave* lens has the same effect as two prisms with their *points* turned together. Fig. 23 also illustrates *spherical aberration.*

Fig. 24.

Illustrates the influence of the double-convex lens to *invert* and *magnify* objects.

* * *

CHART NO. SIX.

Fig. 1.

Decomposition and recomposition of light. The prism L separates the ray B into *twenty-one* different rays, seven *colored* or *lighting* rays, seven *heated* or *calorific* rays, and seven *chemical* rays. *Below* the red ray, quite *out* of the color, is the most *powerful calorific* ray, each one diminishing in intensity of heat as we pass *up*, and lying a little below its respective color. On the contrary, the most *powerful chemical* ray is at the *top*, above the violet, and quite *out* of the color, each diminishing in intensity of effect as we pass *down*, until we reach the strongest *lighting* ray, (which is the *yellow*,) where the chemical effect diminishes to *nothing;* then increasing again and, finally, diminishing to nothing at the lower extremity of the spectrum; thus showing *two maxima* of chemical influence. The most powerful *coloring* or *lighting* ray is the yellow, the lighting effect diminishing from this color to nothing at either end of the spectrum. See Fig. 3. Intercepting the lens C, these rays are again united, forming "white light" as it was before decomposition.

FIG. 2.

Decomposition of light, and the several rays so united as to produce but *three* primary colors, instead of *seven*. By passing blue and yellow through prisms again (LL) there is no *farther* decomposition; but by uniting them with each other, by prism F, they form Green; Yellow and Red form Orange. Red and blue form Violet and Indigo. Still no *two* colors *alone* make a *third* color in the *solar spectrum*, but there must be more or less of *all* the *three* primary colors (R., Y., B.) to make the other *four* (V., I., G., O.) See

Fig. 3.

Here the curved lines above show what *proportion* of the *primary* colors (R., Y., B.) enters into the composition of the *seven* colors below. The dotted curved lines *below* the colors show the relative intensity, at different points of the spectrum, of the *chemical*, *lighting*, and *calorific* effects.—C, curve of *chemical* intensity—E, curve of *thermal* intensity—the other line is the curve of *luminous* intensity.

Fig. 4.

By painting the seven colors on a circular plate, (in the proportion of 80° V., 80° I., 60° B., 60° G., 40° Y., 27° O., 45° R.,) and causing it to revolve, white light is produced (nearly white.)

Fig. 5.

Shows decomposition and reflection of light, by a drop of water or rain. This is the kind of *refraction* and *reflection* that produces the *primary* rainbow.

Fig. 6.

Represents the kind of reflection and refraction that constitutes the *secondary* rainbow. The spectrum in this rainbow, in the order of its colors, is the reverse of that in the *primary*.

Fig. 7.

Illustrates the *formation* of the rainbow. Drop 1 sends to the eye the R. ray; drop 2, the O.; drop 3, the Y.; drop 4, the G.; drop 5, the B.; drop 6, the I.; drop 7, the V. S, S, S, rays of the sun.

Fig. 8.

Represents the earth surrounded by the atmosphere, to show that the sun is seen several minutes before it is actually above the horizon. Line A, the horizon. As we see objects in the *direction of the rays just as they enter the eye*, the ray from the sun *below* A will seem to come from the sun *above* A. This ray is bent or refracted by the air. In this way the sun is visible several minutes after it actually goes down in the evening.

Figures 9 & 17.

Illustrate *mirage*, which is caused by rays of light from objects passing through strata of air of different degrees of density; together with the fact that objects *seem* to be in the direction of rays at the instant they are entering the eye. By the *direct* rays the object A′L′ (Fig. 9) will be seen; by the *curved* rays, (which are refracted by the air being unevenly dense,) the object AL will be seen in the air. Fig. 17 is a kind of mirage seen in hot, sandy countries.

Fig. 10.

The Eye. B, the *sclerotic* coat; H, the *choroid* coat; E, the *retinal* coat; FD, *cornea*, (in front;) FD, *iris;* O, *crystalline lens.* The explanation of this figure will be found in any Natural Philosophy.

Fig. 11.

Shows that the *angle of vision* grows smaller as the distance of the object from the eye increases.

Fig. 12.

Represents the eye of a *near-sighted* person: the crystalline lens is too *convex;* hence *concave* glasses are needed to *counteract* this increased convexity till the image shall fall on the retina.

FIG. 13.

Shows the eye of a *long-sighted* person: the crystalline lens is not *sufficiently* convex; hence *convex* glasses should be used to *increase* the convexity till the image shall fall on the retina.

FIG. 14.

Shows that rays of light, from objects passing through a small aperture, cross each other, and would throw an inverted image upon a wall or canvas in a dark room. This makes a very good *camera obscura.*

FIG. 15.

The *camera lucida*, for sketching landscapes, buildings, &c. C is glass; FL, the light. The surface FE and EA reflect the rays to a point above, where the eye is to be placed to view the image, at DH.

FIG. 16.

The *camera obscura*, used for the same purpose as the last two.

FIG. 18.

Magic lanterns, used to produce a *magnified image* of a *small object.* The *lamp*, the *mirror* A and the *lens* T, are to produce and concentrate the light on the object F. The small double-convex lens L, magnifies the object, as seen at FF.

FIG. 19.

The *simple microscope*, or magnifying glass, which is merely a double-convex lens. It magnifies by increasing the angle of vision, as seen by the figure.

FIG. 20.

The *compound microscope.* The *small* lens L is the *object-glass;* the *large* one, the *eye-glass.*

FIG. 21.

The *compound microscope*, provided with a third lens, FH, called the *field-glass*, to increase the field of view.

FIG. 22.

Illustrates how the several lenses are adjusted to each other, by means of tubes fitted to slide one into another.

CHART NO. SEVEN.

m

FIG. 17.

Solar microscope. Lens L is to concentrate the light on the object A. T, the magnifying glass.

FIG. 18.

Gregorian reflecting telescope.

FIG. 19.

Newtonian reflecting telescope.

FIG. 20.

The large reflecting telescope of the Herschels and the Earl of Rosse; so constructed as to dispense with the small mirror.

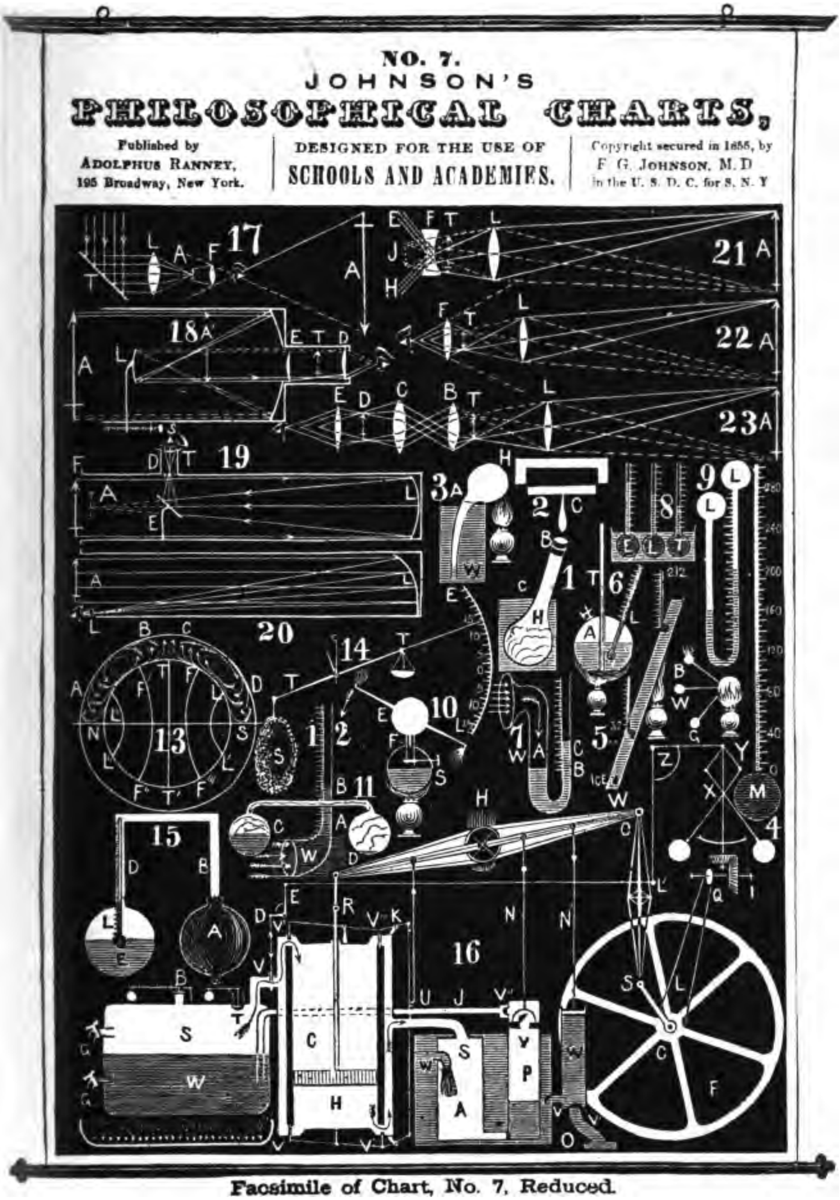

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FIG. 21.

The *Galilean refracting telescope*, consisting of a double-concave and a double-convex lens; used to view objects at short distances, as across large rooms and theaters. It is termed an *opera-glass.*

FIG. 32.

A *common refracting astronomical telescope.*

FIG. 23.

A *common refracting terrestrial telescope*, provided with two additional lenses, to invert the object the *second* time, that it may be viewed right side up. This is the *common spy-glass.*

The remaining figures of this Chart are to illustrate some of the phenomena of *heat*, rather *caloric.*

FIG. 1.

Shows that fluids will boil with less heat when atmospheric pressure is removed. Partly fill the glass flask H with water; cause it to boil, (over a spirit lamp,) and in two or three minutes cork the flask; move the lamp and it will cease to boil; in a few minutes plunge the flask into cold water, which will cause it to boil again; and this is owing to the cold water condensing the steam, thereby making a vacuum, which removes atmospheric pressure.

FIG. 2.

Shows that heat *expands* bodies. When cold, fit block C, (of any metal) into block H—now heat block C and it will more than fill the opening.

FIG. 3.

Shows that *air* (and all the gases) expands when heated. Put the *neck* of flask A into the water, then heat the air in the *bulb* and it will expand; which is shown by the water being driven down into the neck.

FIG. 3.

Shows that *fluids* expand when heated, and that some expand more than others by the same degree of heat. Fill the *bulbs* of the flasks with *different* fluids and immerse them in the same vessel of warm water.

FIG. 4.

The *common thermometer.*

FIG. 5.

Shows that water is a non-conductor of heat, and that when heated, the heated portion rises to the surface. The tube is filled with cold water, having two thermometers inserted, and a piece of ice in the bottom; now, by applying the lamp, the water will *boil* at the *surface* while the ice remains in the bottom. The thermometers stand at the *freezing* and *boiling* points.

FIG. 6.

Shows the intensity of heat necessary to cause water to boil when submitted to different degrees of pressure. In the water is a thermometer, L. T is a tube extending down into a quantity of mercury. Open the faucet and set the water to boiling—the mercury in the *tube* and *vessel* will be on a level and the thermometer will stand at 212°. Now, shut the faucet and the steam will press on the water, which is shown by the mercury rising in the tube,—the *increase* of heat, necessary to make the water boil, under this increase of pressure, will be shown by the thermometer rising above 212°.

FIG. 7.

An instrument for ascertaining the *force* and *velocity* of wind.

FIG. 9.

Differential thermometer.

FIG. 10.

Rotary steam engine, which operates on the same principle as Barker's Mill, except *steam* is forced out of the apertures instead of *water*.

FIG. 11.

A glass tube with two bulbs; the air being extracted from them and one partly filled with ether—now the mere warmth of the hand will cause the ether to boil.

FIG. 12.

An instrument for ascertaining the *force* and *velocity* of running water.

FIG. 13.

Represents the earth surrounded by the atmosphere, to illustrate the phenomena of wind as caused by heat.

FIG. 14.

An instrument for ascertaining the amount of moisture in the atmosphere. S, some light spongy substance.

Fig. 15.

An instrument for learning the *dew point* or the degree of temperature at which dew will begin to form. The fluid, E, is ether; and, the remainder of the instrument being free from air, if cold water or ether be poured on bulb A, the ether vapor *within* will be condensed and more vapor will rise from bulb L, which will extract caloric from the ether, E, till *dew* is formed on the outer surface, by condensing and freezing the moisture of the atmosphere. The *temperature* of this point will be shown by the *thermometer* within.

Fig. 16.

The low-pressure steam engine—representing the *regulator* and its attachment, and the process of operating the *steam-valves.*

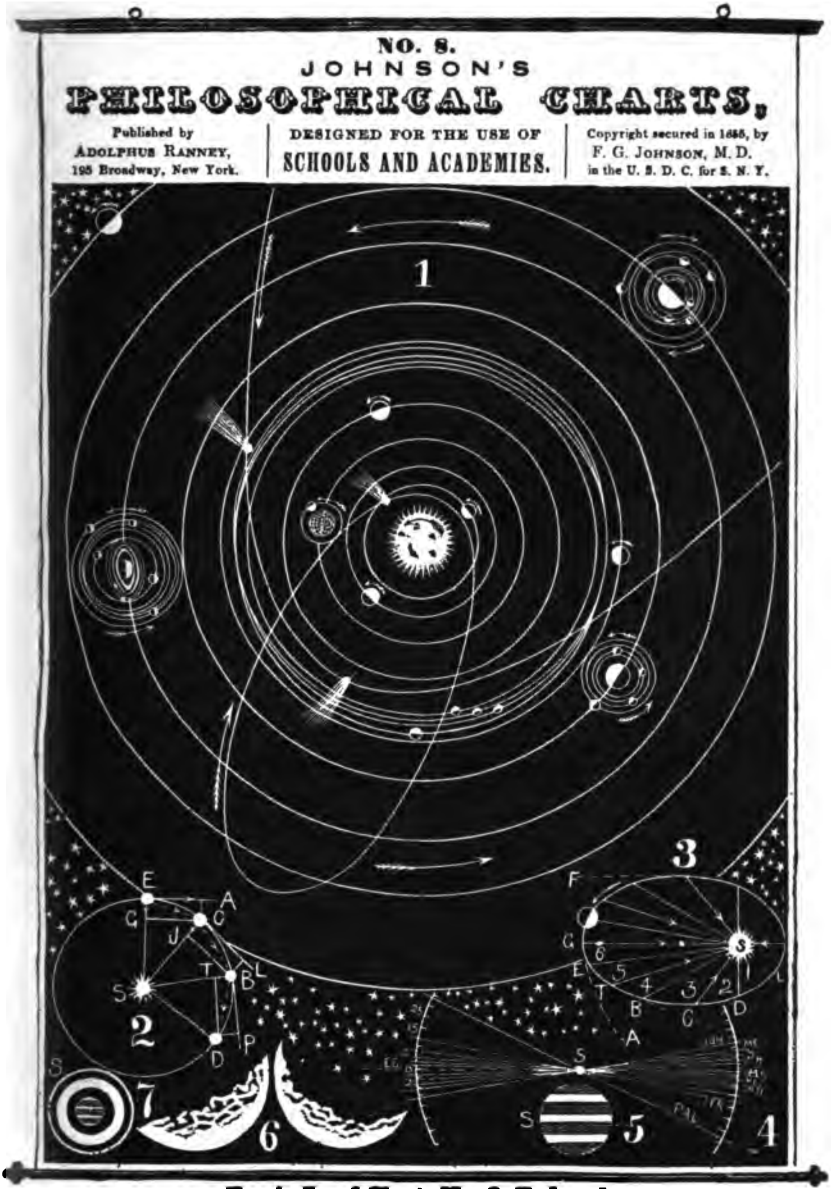
Any teacher will be able to explain the engine, and its operation.

* * *

CHART NO. EIGHT.

Fig. 1.

The *Solar System.* The *Sun* is situated at the center, having the *dark spots* represented. Leaving the Sun we first come to *Mercury*—next, *Venus*—then the Earth, with its satellite, the Moon—next,



NO. 8.
JOHNSON'S
PHILOSOPHICAL CHARTS,

Published by
Adolphus Ranney,
195 Broadway, New York.

DESIGNED FOR THE USE OF
SCHOOLS AND ACADEMIES.

Copyright secured in 1855, by
F. G. Johnson, M. D.
in the U. S. D. C. for S. N. Y.

Facsimile of Chart, No. 8, Reduced.

Mars—then, the five Asteroids, *Vesta*, *Juno*, *Ceres*, *Pallas*, and *Astrea*—next, *Jupiter* with *four* moons —then, *Saturn*, with *two rings* and *seven* moons—next, *Uranus* or *Herschel*, with *six* moons—and lastly *Neptune*. The two elliptical orbits are those of *comets*. The exact relative distances and magnitudes are not here represented; for instance, the distance between the orbits of Uranus and Neptune should be equal to, or greater than, the distance from the sun to Uranus.

Fig. 2.

Is to illustrate curvilinear or circular motion.

FIG. 3.

Illustrates various phenomena respecting the motion of bodies in elliptical orbits.

FIG. 4.

Represents the magnitude of the several angles which the planes of the planetary orbits form with the plane of the ecliptic.

FIG. 5.

Shows the appearance of Jupiter's *belts* as seen by a telescope.

FIG. 6.

Represents the appearance of the moon when seen through the telescope.

FIG. 7.

Shows the appearance of Saturn and its rings.

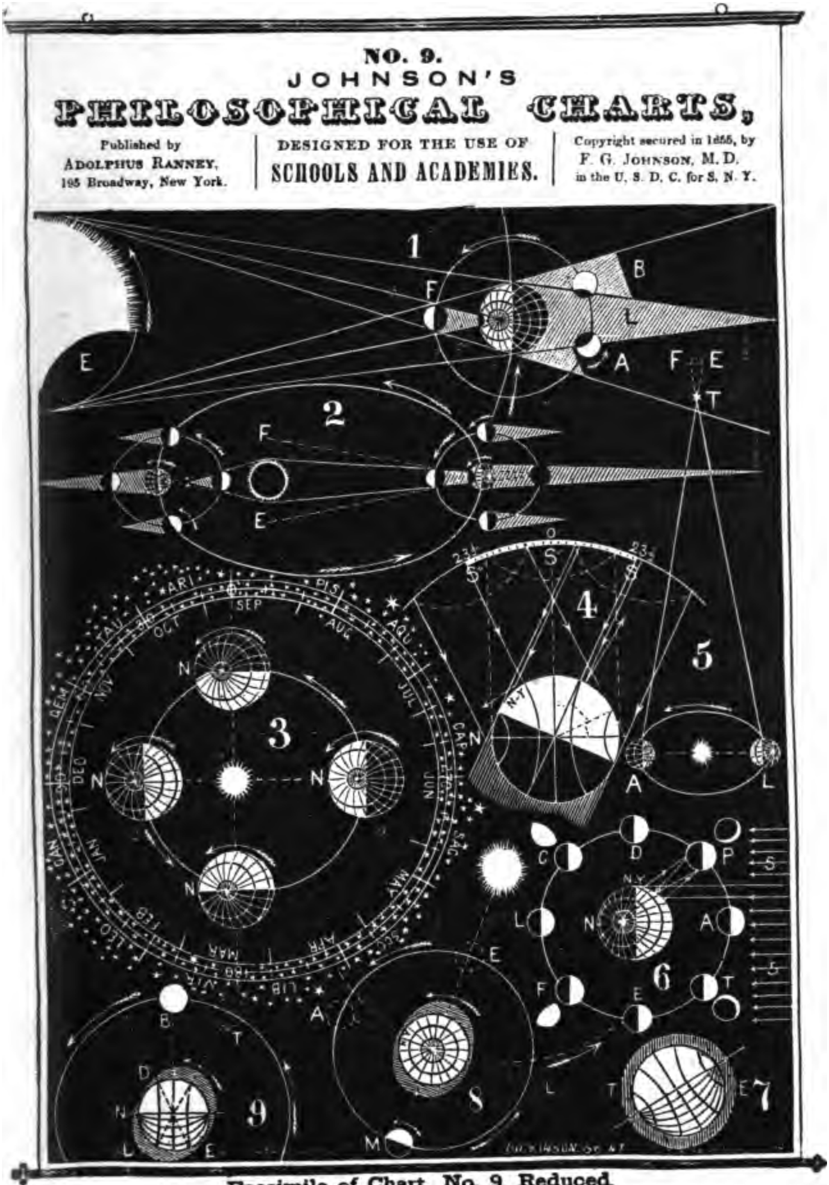
CHART NO. NINE.

Fig. 1.

Represents some of the phenomena of *eclipses;* showing the moon's orbit around the earth, and part of the earth's orbit around the sun—L, the *shade* (or umbra) of the earth, and B, A, the *lesser shade* (or penumbra)—F, moon passing between earth and sun, causing an eclipse of the sun. Opposite to F, is seen the moon passing in and out of the earth's shadow, causing an eclipse of the moon. The dark spot, E, on the sun, represents its appearance when partially eclipsed.

Fig. 2.

Also represents phenomena of *eclipses;* showing the *elliptical form* of the orbits of the earth and moon. Between E, F, is seen the sun, situated in one of the *foci* of its orbit—on the left is the earth at *perihelion,* (point nearest to the sun,) situated in one of the *foci* of *its* orbit; and still on the left is the moon in its *perigee,* (point nearest to the earth.) On the right of the sun is the earth in *aphelion,* (point most distant from the sun,) situated in one of the *foci* of its orbit; and still on the right is the moon in *apogee,* (point most distant from the earth.) The sun in this figure represents an annular (ring-like) eclipse; which occurs when the moon is so near the sun as to cause its shadow to terminate before it reaches the earth; and this will happen when the



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Facsimile of Chart, No. 9, Reduced.

earth is *in* or *near perihelion* and the moon *in* or *near apogee.*

Fig. 3.

Shows the *ecliptic*, *zodiac*, and their division into *signs* and *degrees*—also, the relative position of *sun*, *earth*, and *stars* at different seasons of the year.

It will be seen by this figure that, if the earth on the right of the sun were turned around its axis, the sun would still shine upon all the north frigid zone; but when the earth shall have passed around to the left of the sun, (in its *orbit*,) the north frigid zone is wholly turned *from* the sun; hence, it is not true, at all seasons of the year, that the earth's revolution on its axis, produces the phenomena of day and night on all its parts.

Fig. 4.

Shows the position of the sun at different seasons of the year with reference to the zones of the earth—ascension and declension. Rays of light coming from the sun, when it is below the equator, strike the earth at N. Y. obliquely and glance off; but when the sun is north of the equator, they strike more perpendicularly and are reflected back into the air.

Fig. 5.

Illustrates an *annual parallax*, or the angle under which the earth's orbit would be seen from the star T. The distance from A to L is one hundred and ninety millions of miles; but supposing T to be the *nearest* fixed star, even then, the angle ATL

FIG. 1.

(On the left.) A piece of *loadstone*, a natural magnet. It is a kind of iron ore. N, the north pole, and S, the south.

FIG. 1.

Magnetic needle.

FIG. 1.

(On the right.) A magnet laid upon a piece of sheet-iron in the form of a star. The *polarity* of the *points* of the star will be opposite to that of the center.

FIG. 2.

Two artificial magnets. It is a principle of magnets, that their *like* poles *repel*, while there *unlike* poles *attract* each other; hence, in the figure, if the N. pole of one magnet be applied at the *middle* of the other, the S. pole of the latter will leave the *end* and come to the center, and both extremities will have the N. polarity.

FIG. 3.

(On the left.) Several straight magnets to show that they attract each other according to the above principle.

FIG. 3.

(On the right.) Illustrates that a magnet loses none of its force by imparting magnetism to other bars of iron. If F be a magnet and the scale-pan suspended to it by the small bar T, a *greater* weight will be sustained by bringing the unmagnetized bar L in contact with the magnet F.

FIG. 4.

The *horse-shoe* or *U magnet.*

FIG. 5.

Shows that one polarity will neutralize the other. Take a soft piece of iron formed like the letter Y; place upon each arm a magnet with their similar poles in the same direction; then will the polarity of the lower end of Y be similar to the lower ends of the magnets, and bits of iron will be attracted by the lower extremity of Y. But if *one* of the *magnets* be *reversed*, (as in the figure,) then will the lower extremity of Y have *two* polarities, or *none*—at any rate, the magnetic force is destroyed and the key falls off.

FIG. 6.

Shows the position of the *magnetic poles* and *magnetic equator* of the earth, and also the *dip of the magnetic needle* in different latitudes. The *magnetic* poles and equator do not coincide with the *geographical* poles and equator of the earth.

FIG. 10.

A *magnetic dip-needle.* It is placed on a spirit level.

FIG. 12.

(Above.) A piece of paper having iron filings sifted over it and a horse-shoe magnet held below it with the arms directed upward. The position of the filings shows what are called the *magnetic curves.*

FIG. 12.

(Below.) Is to illustrate the *molecular theory* of magnetism, which supposes each particle of a magnet to be possessed of two *magnetic* fluids—the *boreal* and *austral;* the *boreal* being collected on the side of the north pole, and the *austral* on the side of the south pole.

ELECTRICITY.

Fig. 13.

The *cylinder electrical machine.* L, the *cylinder*—C, the *rubber*—F, the *prime conductor.*

Electricity is supposed to be *positive* and *negative;* —*similar* currents *repel*, and *dissimilar* currents attract each other.

Fig. 14.

A piece of *glass* and *sealing-wax*, having a light *pith-ball* suspended between them, to illustrate some of the phenomena of electricity.

Fig. 14.

(Below.) A strip of tin foil pasted on a plate of glass and letters scratched on, by removing the foil—by connecting one end of the foil with the prime conductor, and completing the connection of the other end with the ground, so that electricity passes the letters will appear in sparks of fire

Fig. 9.

Illustrates *electrical induction.* Let P be a *prime* conductor, charged; and NP, a secondary conductor, having pith-balls suspended at either *end* and *middle.* The balls at either *extremity* will become charged and *repel* each other, while those in the *center* will remain *undisturbed.*

Fig. 21.

Is to illustrate *electrical induction*, *attraction*, and *repulsion;* by means of which the *images* are kept dancing up and down. The *upper* plate connects with the *prime conductor* and the *lower* one with the *earth.*

Fig. 22.

A set of *electrical bells*, to illustrate the above principles, (induction, attraction, and repulsion.)

Fig. 17.

The *Leyden jar* and *discharger*.

Fig. 18.

Several arms adjusted on a pivot, with sharp points bent at right angles with the arms, to show that *electricity passes off at points*, causing *reaction*, and thus producing *motion.*

Fig. 7.

The *quadrant electrometer*. The electric current passes down the standard, charges the ball T, causing it to rise. It never rises higher than 90° on the arc.

Fig. 15.

Pith-ball electrometer. The balls being charged they repel each other. If gold-leaf be used instead of pith-balls, it is termed a *gold-leaf electrometer*.

Fig. 11.

An *electroscope*, for detecting the *presence of electricity* and *testing its polarity*, whether it be positive or negative. In the lower part of the jar is a *dry electrical pile*, terminating in two flat metallic plates, having a bit of gold leaf suspended between them; one of these plates will be *positive*, the other *negative*. If the *slightest* current pass down the gold leaf, it (the leaf) will pass to the plate of the opposite polarity.

GALVANISM.

FIG. 19.

A basin partly filled with dilute sulphuric acid, having a slip of zinc and copper inserted and joining each other at the top, to illustrate the *galvanic circle;* or the production of electric currents by chemical action. The *positive* current passes in the direction of the *entire arrows*, the *negative* in the direction of the *dotted arrows*.

FIG. 20.

Galvanic trough battery.

FIG. 21.

(Below.) Is a *voltaic pile.* Connected with the poles of this pile are pieces of charcoal; when these bits of coal are brought near each other, brilliant sparks of fire will pass from one to the other, as at L.

FIG. 8.

The *common sulphate-of-copper battery*, consisting of two copper cylinders soldered to a copper bottom, having a movable *zinc* partition between them.

FIG. 30.

Grove's battery, consisting of *zinc* and *platina*, two liquids, (*dilute sulphuric acid* and *strong nitric acid*,) and *two vessels.* The cup in the center is unglazed earthen ware, containing the nitric acid and platina: the outside cup is glass.

This is the battery used for the magnetic telegraph.

FIG. 9.

(Below.) Illustrates the process of decomposing water with electricity. Two glass tubes, inverted and filled with water, are placed over the extremities of wires, which come from the battery C: the water in the basin makes the connection between the wires. *Hydrogen* being electrically *negative*, *oxygen positive*, these two gases will have *greater* affinity for their respective *electric poles*, than for *each other;* hence the decomposition.

ELECTRO-MAGNETISM AND MAGNETO-ELECTRICITY.

If a current of electricity be made to pass around a bar of *iron*, it becomes *transiently* magnetic; if around *steel* it becomes *permanently* magnetic: this is called *electro-magnetism.* If a magnet be placed within a coil of wire, with its ends united, an electrical current will be excited: this is termed *magneto-electricity.*

FIG. 16.

A magnetic needle, having a wire passing around it, to show the effects of an electrical current upon the needle as it is made to pass *above*, *below*, and in different directions *around* it.

FIG. 16.

(Below.) Represents the earth as having a current of electricity passing around the equator, to illustrate its effects upon the needle, in directing it in a north and south position.

FIG. 23.

A coil of insulated wire, having a magnet passing through the center. C and A are two metallic handles on the course of the wires; by connecting their extremities with the poles of a battery, and causing sudden breaks in the current, (by drawing one end of the broken wire across the file F, while the other is attached to it,) severe shocks will be felt by grasping the handles, C, A.

FIG. 20.

(Below.) A dish of mercury, with a stationary magnet in the center; the dish and mercury constitute a connection between the poles of the battery. The positive pole being free to move will *rotate around the magnet.* The converse of this is true: if the pole be stationary while the magnet is free to move, the *magnet will pass around the pole*, (or wire.)

FIG. 25.

Illustrates how electro-magnetism may be applied to the propulsion of machinery, ringing of bells, &c. L, a soft piece of iron, wound with insulated wire which connects with the battery, and upon the wheel are three straight bars of iron. Now, this U magnet attracts the *nearest* iron bar, draws it down and turns the wheel; but just as the bar reaches the ends of the magnet, the electric current is broken by the *small* wheel raising the wire from the little cup of mercury T. The current being broken, the magnet ceases to attract the bar, and it (by momentum of the wheel) passes *by* till the *next* bar shall be nearer the magnet than *this*, at which instant the connection is again completed, and so on, indefinitely.

On the right is a wheel, connected to the main shaft by a cord, by means of which the bell may be rung.

FIG. 25.

(On the right.) Two semi-circular bars of iron linked with a coil of wire, to illustrate the *power* of a magnet produced by an electric current.

FIG. 28.

Illustrates the principles of Morse's *magnetic telegraph.* P, the roll of narrow paper; C and L, the magnet and iron bar, which, by the electric current, operate the style or point on the paper at T, as it (the paper) passes along by means of the machinery which is moved by the weight W. The bell is to call the attention of the operator, whenever a communication is to be forwarded. The forwarder of the message, (who may be hundreds of miles distant,) completes the electric current, which magnetizes the bent bar, C, and draws down the armature or bar L, which makes an impression on the paper at T. By breaking the current, the bar L springs up. The impressions on the paper may be varied to represent the letters of the alphabet, by varying the continuation of the current. There are improved telegraphic *machines*, which render the message in regular English print.

THERMO-ELECTRICITY.

By heating the junction of two dissimilar metals, an electric current will flow from one to the other: this is termed *thermo-electricity.*

FIG. 24.

Illustrates the production of thermo-electric currents. The bar T may be bismuth, tin, lead, or zinc —bind over it a slip of copper, F—suspend an astatic needle, (which consists of two magnetic needles of equal power, placed on the same shaft, with their poles reversed.) This needle is termed the astatic galvanometer—used to determine the presence of currents. If the two metals be heated at T, the needles will rotate in *one* direction: heat the *opposite* extremities and they will turn the *other* way.

FIG. 27.

The *thermo-electric revolving* arch. The arched wire is *brass*, the cross wire *German silver*. Direct the cross wire *east* and *west*, heat the western junction, and this will produce a current up the arch, and so around, and this current will give polarity to the north and south faces of the arch. The *north* face will have the *south* polarity—the arch, therefore, will move round to present its *other* face to this pole; but, in turning, the *other* junction is brought into the flame, which will *reverse* the polarity of the faces, and this will cause it to *still* move on, and on, indefinitely.

By placing the arch upon one of the arms of a U magnet, as in the figure, the rotation will be more rapid.

On the left of Fig. 25 are two metallic bars, soldered together at one extremity, and having wires attached: in this case the bars are *bismuth* and *antimony*. If, by connecting the wires with a battery, a voltaic current is made to pass from the *antimony* to the *bismuth*, the temperature of the compound bar is *raised;* if the current passes in the *opposite* direction, *cold* is produced.

Fig. 26.

Illustrates the method of *electrotyping.*

Fig. 29.

Illustrates Colt's *submarine galvanic battery*, for blowing up ships, and the method of *blasting rocks under water* by means of electricity. Within the keg of powder the circuit is completed by means of a very fine platina wire, which, when the electrical current passes, becomes instantly *heated*, even to a white heat, which, of course, fires the magazine. The *galvanic* battery may be placed on a tower or city hall, at any convenient distance from the bay or harbor.

THE END.

COMMENDATIONS

TO

Dr. Johnson's Philosophical Charts.

The following are a few of the many Commendations already received in favor of this work.

From the Christian Advocate and Journal.

DR. JOHNSON'S PHILOSOPHICAL CHARTS, designed for the use of Schools and Academies. Published by A. RANNEY, 195 Broadway, New York.

Good school books and their educational appliances have rapidly increased among us of late years. some of our best minds have given their attention to the preparation of text-books of science, and no one can fail to note the increased facilities which have been furnished to aid both the teacher and scholar. Dr. Johnson's Philosophical Charts especially deserve the attention of teachers. They are ten in number and include about three hundred drawings, illustrating the most important principles of Natural Philosophy. Thousands of dollars would be necessary to purchase all the apparatus represented by the figures on these charts. They will supply a want much felt by teachers in our common schools and such academies as are not furnished with a complete philosophical apparatus. Teachers who are to some extent supplied with philosophical instruments, will find these charts admirably adapted to facilitate their explanations of the general principles of Natural Philosophy. We most cheerfully commend these charts to the attention of teachers, and would gladly know that they were introduced into all our schools.

These Philosophical Charts are accompanied by a Key, a small pamphlet, giving ample directions as to the manner of using them by the teacher, and the pupils. The author, after graduating at the Wesleyan University at Middletown, commenced life as the teacher of an academy, and finding how difficult it was to communicate instruction in Natural Philosophy, or to enlist the attention of his pupils, without the aid of philosophical apparatus, the price of which was beyond the reach of private means, he was led to substitute such expensive aids by drawings representing them, and finally to the invention of these charts, which have challenged the approval of men of high rank as professors in universities and colleges, and who, as teachers, were best qualified to judge of their utility.

The following letters from gentlemen of high professional reputation will better recommend these Charts to our readers than any thing we can offer.

DR. BOND.

From the Wesleyan University, Middletown, Conn.

DR. F. G. JOHNSON,

MY DEAR SIR :

I have examined your "Philosophical Charts," and the accompanying "Key," with some care and no little interest. Their importance, both to teachers and pupils, cannot be over estimated.

To attempt, at the present day, to communicate, or to acquire, a competent knowledge of any of the different branches of Natural Philosophy without the aid of apparatus or diagrams, would be considered folly; but the necessary apparatus, as you justly remark, is beyond the reach of very many schools and academies; and although the text-books, generally used at the present time, abound in "illustrations," which afford important aid, still in the proper exercises of the lecture room, larger figures are much needed, to which the attention of a whole class can be directed at the same time. This want your "Charts" admirably supply, and I rejoice at their appearance, and trust they will at once come into general use.

JOHN JOHNSTON,
Prof. Natural Science.

In the above, we entirely concur.

AUGUSTUS W. SMITH. L.L.D.,
Pres. Wesleyan University, and Prof. Math. & Astron.
J. W. VANBLECK,
Adj. Prof. Math.

From the Hon. Theodore Frelinghuysen, Pres. Rutgers College, New Jersey, formerly Chancellor of New York University.

Dr. Johnson's "Philosophical Charts," designed for the use of Schools and Academies, furnish an admirable substitute for the far more expensive apparatus. These Charts hung on the walls of the school room, in all which I hope to see them, will spread before the scholar a palpable illustration of the great laws in Natural Philosophy. He will learn much of God, from the works of His hand and the ordinances of His appointment.

The small volume that accompanies them, and a little explanation from the teacher, will render the charts one of the most useful means of instruction.

THEODORE FRELINGHUYSEN.

From the Hon. Horace Mann, Pres. Antioch College, Ohio, formerly Sec. Board of Education of Mass.

* * * * * * * In schools where there is not the philosophical apparatus, these beautiful "Charts" will be an excellent substitute for it; and I shall be glad to show and to commend them to such persons as can best introduce them into schools, and especially to such as shall go forth from our institution to become school teachers.

HORACE MANN.

From the Hon. Henry Barnard, L.L.D., Editor of American Journal of Education, formerly Sec. Board of Education of Conn., also State Sup. of Schools for R. I.

* * * * I have examined Dr. Johnson's "Ten Large Philosophical Charts," prepared for the use of schools and academies, and have recommended, and shall continue to recommend. their introduction on every suitable opportunity.

HENRY BARNARD.

From the City Supt. of Schools of Brooklyn, N. Y.

Dr. Johnson's "Philosophical Charts" have been prepared specially for the use of schools and academies. A glance at them only is needed to satisfy the practical teacher that they will materially aid in illustrating the important principles of Natural Science to the eye of the learner, in the most agreeable and explicit manner.

They are also placed within the reach of all such schools as may be unable to procure so desirable, yet costly, apparatus.

J. D. GIDDINGS.

DR. JOHNSON'S PHILOSOPHICAL CHARTS.

From Benjamin Silliman, L.L.D., Prof. Emeritus in Yale College.

Dr. Johnson's Philosophical Charts, published by A. Ranney, New York, are well worthy of the attention of all teachers and learners of the different branches of Natural Philosophy, to which they relate.

The diagrams drawn in colored or contrasted lines, upon a black ground, are perfectly distinct and intelligible, and the large size and handsome mounting of the charts give them a striking and attractive appearance.

To teachers without aparatus, they must be an invaluable acquisition, and a very useful one to those who *have* the instruments.

Such illustrations, as they speak to the mind through the eye, admit of indefinite extension to every branch of Natural Science.

BENJ. SILLIMAN.

From Rev. Francis Wayland, D.D. L.L. D., Formerly Prest. of Brown University.

"I have carefully examined Dr. Johnson's Philosophical Charts, and think them well adapted to the purpose for which they are intended. They will afford important aid to instructors in academies and schools where Philosophical instruments are not furnished to perform illustrative experiments. In many cases they will also be of service even in addition to any ordinary apparatus.

FRANCIS WAYLAND.
Providence, R. I., Feb. 8th, 1856.

Dr. Johnson's Philosophical Charts, designed for the use of schools and academies are now hanging in our office, and we can heartily and conscientiously commend them, as fine and very useful appendages for the wall of a school-room. They are drawings on a black ground, of all the diagrams needed in teaching Natural Philosophy and its several branches, as well as Astronomy, Magnetism, Galvanism, &c.

The designes are colored beautifully. They will save a teacher a great deal of labor, and will enable him to make use of the pupils' eyes, as their ears and thoughts, in teaching this very important part of human knowledge.

And even if the Book of Natural Philosophy is never used in a school, these charts will then be very useful, and they can be made very amusing and instructing.

We commend them to the notice of school committees.

ROBT. ALLYN,
Office of Commissioner of Public Schools.
Providence, R. I., Dec. 29, 1855

I fully concur in the recommendation of Mr. Allyn.

DAN LEACH,
Supt. Public Schools, Providence

From the New York Evangelist.

A series of charts has been planned by Dr. Johnson, the design of which is to explain th principles of Natural Philosophy. They are ten in number, each 34 inches by 52, and colors and contain about three hundred drawings. These illustrate all the principal experimen and demonstrations occurring in the Science, in a very striking manner. They supply th place of costly apparatus, and bring the facts of the science with great vividness before th pupil's mind. They cover the whole ground of the science as taught in schools, and would seem to give an interest and distinctness to it which nothing else but elaborate apparatus could effect Their economy and value will make them popular and useful

DR. JOHNSON'S PHILOSOPHICAL CHARTS.

From the Penn. Medical University, Phila.

I have examined Dr. Johnson's "Philosophical Charts," and am much pleased with them. I consider them of very great value in teaching the sciences to which they relate, and think that no teacher in that department can afford to be without them. We have seen no work so well calculated to thoroughly impress the first principles of Natural Philosophy upon the mind of the learner.

As the author justly remarks, "Habitual demonstration and constant reviewing are indispensable to the highest degree of success in the great art of teaching; and these Charts are particularly adapted to facilitate both of these exercises.

J. M. MACOMBER, A.M., M.D.
Prof. of Chemistry & Nat. Philosophy.

From Daniel F. Tompkins, Esq., Mem. Board of Education, of Newark, N. J.

Having carefully examined Dr. Johnson's "Philosophical Charts," I do not hesitate to say, I consider them one of the most valuable contributions of the age to the great cause of education.

The Natural Principles which they illustrate are in themselves of the first importance, and the manner of the illustration is exceedingly attractive, comprehensive, and simple. Practically, these "Charts" cover the whole ground of Natural Science as taught in schools and academies, and, when used with their accompanying "Key," will successfully take the place of apparatus that would cost thousands of dollars.

No people have more reason than the Americans to be interested in the diffusion of a knowledge of Natural Philosophy, the principles of which underlie so much of our real greatness, comfort, and wealth, as a nation. In this view, I think the "Charts" are calculated to do much good, and I hope they may soon find their way into every school room in the land.

DANIEL F. TOMPKINS.

From an Experienced Instructor.

I have examined the series of "Philosophical Charts" prepared by Dr. F. G. Johnson, and most cheerfully commend them to public favor, as filling a place heretofore vacant in works compiled for school use. Their arrangement, comprehensiveness, and simplicity, render them a very valuable assistant, both to the pupil and teacher.

D. H. PEASE,
Norwalk, O.

From the "N. Y. Daily Times."

To Dr. Frank G. Johnson, of Brooklyn, we are indebted for a series of Ten large Charts, (published by A. Ranney, New York,) which are intended for use in schools, to impart information upon Natural Philosophy, in the absence of apparatus. They contain the essence of a vast number of works upon this most important branch of education, and are capable, in the hands of competent persons, of correctly and fully communicating, by simple and almost tangible illustrations, the principles of the Natural Sciences. It is an advantage, that these Charts may be used with the ordinary text-books. Ninety-nine out of every hundred of our public schools are not supplied with the means of purchasing the apparatus, heretofore considered necessary, if not indispensable, for instruction in Natural Philosophy. These Charts form a very inexpensive substitute for the apparatus. What maps are to Geography, these Charts are to Natural Science. Teaching by the eye has so many advantages, that we give our hearty commendation to Dr. Johnson's most useful, comprehensive, and well-executed Charts.

With their aid the great primary and leading principles of the most important and practical branches of Natural Philosophy will henceforth be most easy of acquirement.

From the N. Y. "Commercial Advertiser."

* * * * * * These Charts and the accompanying Key are not intended to supersede the ordinary text books, but to be used as auxiliaries in teaching the science; and their merit is obviously so great that no school-room in which Natural Philosophy is taught should be without them. The Charts may be had for a few dollars, while they will answer nearly the same purpose for the instruction of classes as apparatus that would cost thousands of dollars. They contain about three hundred drawings, illustrative of all the more important principles of the Natural Sciences as generally taught in schools; and the Key gives a brief explanation of each figure. All experienced teachers recognize the utility of visible symbols to illustrate the points of verbal instruction, and these Charts only need to be made known to be adopted in every institution of learning in the country.

From the "N. Y. Daily Tribune."

JOHNSON'S PHILOSOPHICAL CHARTS, (A. RANNEY,) is a novel apparatus for the study of Natural Philosophy, consisting of a series of diagrams illustrative of the main principles of the science, together with an explanatory Key showing the purpose of the drawings. The Charts are ten in number, and are mounted on cloth and rollers, so as to be adapted for convenient reference. They are especially intended for the use of common schools, in the absence of the costly mechanical apparatus, which is represented in these diagrams. The plan of this work exhibits no common ingenuity, and in the hands of experienced Teachers cannot fail of a successful practical application.

From the "N. Y. Day Book."

MR. A. RANNEY has recently published a series of Charts, by Dr. F. G. JOHNSON, of Brooklyn, illustrative of Natural Philosophy, which really combine extraordinary advantages. They ought to be in every school-room throughout the land, and there is no doubt that they will find their way to the greater number. The diagrams and drawings supply the place of philosophical apparatus, and offer the teacher every opportunity to illustrate the subject of study. The idea is entirely original and new, and it has met with the warmest favor from the leading teachers of this city and other places. Horace Mann has given them the approval of his judgment, and indeed all who have examined them.

From the "Rahway, (N. J.) Advocate."

WE hope such of our readers as it especially concerns will read the advertisement of MR. RANNEY, (headed "Important to Schools and Academies,") in another column. This advertisement well worth a careful perusal, and the "Philosophical Charts," described therein, will be found in the highest degree deserving the attention of teachers in this vicinity. Instructors of youth, indeed, will find in these Charts a substitute (and a very satisfactory one,) for expensive *apparatus*, which, otherwise, would be required.

From the "Evening Traveller," (Boston.)

MR. RANNEY has just published a series of Philosophical Charts, by Dr. F. G. JOHNSON. These Charts are desined for schools and academies, and are intended to illustrate all the great outline principles of Natural Sciences. They are of colossal size, and suited for the largest school rooms. They are magnificent productions—a novelty of enterprise—and contain about three hundred drawings. To those schools where their means are not sufficient to purchase apparatus, these Charts seem to be exactly what is required to enable the Pupil to understand the text-books. They present to the mind, almost as directly as apparatus, all the illustrations required. They are printed with white lines on black ground, and are to the Natural Sciences what outline maps are to Geography. The idea is a new one, but it meets with a very favorable reception among all Teachers who have become acquainted with it. The Hon. Horace Mann has, I understand, given them the approval of his judgment. They appear to be received with even more favor than was anticipated, and are selling exceedingly well.

From "Life Illustrated," (N. Y.; Fowler & Wells.)

A. Ranney, New York, has published a series of Charts and a Key, for the aid of Teachers, and the benefit of Pupils in Natural Philosophy. We think them well adapted to the purpose, and useful. Teachers will do well to examine them.

From the Boston Watchman and Reflector.

Dr. Johnson's Philosophical Charts, lately published by A. Ranney, constitute one of the very best aids for facilitating the study of the natural sciences that we have ever met with. No school can possess a more useful apparatus, and we have found them admirably adapted to interest and instruct children at home, though designed for schools and colleges.

From the "Niagara Democrat, Lockport, N. Y.

* * * * This series of Charts, as a work on Natural Philosophy, is entirely new. They are executed in the highest style of art. Each drawing is rendered *simple* as practicable without omitting any part necessary to give a clear illustration of the essential law or principle to be explained. The introduction of the physical sciences into our higher "common schools" has created a general and over-increasing necessity for a work of this kind, as a cheap and adequate substitute for the far more costly apparatus. By means of these Charts, the pupil, at the same time he is treasuring up a store of useful knowledge, cultivates the power of expressing and communicating to others in an intelligible manner, what he has acquired. All the virtue that consists in recitation is the tendency it has to fasen the lesson upon the mind, inasmuch as it is *oral* and *demonstrative* in its nature. Yet there is something wanting—something undefined—something not thoroughly understood and appreciated by the learner; in short, something, a correct knowledge of which can never be acquired without having the thing or machine under review, or an adequate substitute therefor, placed before the eye of the student. In general, it is utterly impossible to form a correct idea of a thing which we have never seen, but of which we have merely read a description. Therefore, it becomes *absolutely* necessary that something of a demonstrative, of a practical nature, should be employed as an illustrative auxiliary to the text-book, in order to study Philosophy successfully. For the furtherance of this view of the subject, and as an aid to the instructor in exhibiting the thing as it really is, to the learner; and as a fountain from whence the seeker after knowledge may derive a thorough practical acquaintance with the elementary principles of Philosophy, this series of charts rises pre-eminent over every thing we have yet seen on the subject.

We cannot close this notice without calling the attention of those whose business it is to attend to the procuring of such articles for schools, to the great practical utility of this series of Charts. They are of sterling value, and should claim the attention of all educators. They need only to be seen to be universally admired. A serie[illegible]ld be placed in every school room throughout the land.

DR. JOHNSON'S PHILOSOPHICAL CHARTS.

North Providence, Dec. 27th.

I have examined and seen somewhat of the practical workings of Dr. Johnson's Philosophical Charts. The artistic taste and finish with which they are executed, render them highly ornamental to the school-room, and the peculiar facility with which their numerous diagrams illustrate the various departments of Natural Philosophy, render them eminently useful, not to say indispensible in the teaching of this subject. For reviews and oral instruction, I consider them invaluable. In some of our schools they are already in use, and I earnestly hope they soon will be in all.

JOHN WILLARD,
Supt. of Public Schools.

I fully concur in the above.

A. MEGGETT,
Late of the School Committee.

From the Newark Daily Mercury.

Dr. Johnson's Philosophical Charts are admirably adapted to illustrate the lessons in philosophy taught in our Schools ; and where a complete apparatus is not enjoyed we know of nothing so desirable as these charts. No school should be without them.

From the New York Evening Mirror.

These charts may be used with the ordinary text books, and are to Natural Science what maps are to geography. Most of our schools have not the means for supplying themselves with the usual philosophical apparatus, but none of them are too poor to purchase these admirable charts, which are an inexpensive subititute. We heartily recommend the 'Philosophical Charts" as worthy of the attention of schools and academies.

From the "N. Y. Express."

We have examined the above series of "Philosophical Charts," at the publisher's establishment, 195 Broadway, and have been much struck with the admirable utility they are calculated to serve. They comprise diagrams of instruments, and processes illustrating the expensive apparatus used in the higher acadamies, for the explanation of lectures on Natural Philosophy, Astronomy, Chemistry, &c. The very great outlay necessary for providing even a partial supply of philosophical instruments, or of models of them, precludes the possibility of their use in ordinary schools. With these diagrams, however, a great portion of the difficulty of instructing youth in these branches of knowledge, will be removed. We have not only the fullest conviction of their utility, but know so well the great good they are calculated to facilitate in making the acquisition of an early knowledge of the principles of science and the inculcation of a taste for its study, that we would urge them upon the immediate attention of all who have any charge in the education of youth. Any school possessing these charts, enjoys an advantage which places its efficiency far in advance of those pursuing the ordinary method of chalk and blackboard. Indeed, such is the size, completeness, accuracy and explicitness of these large charts, that we do not see how even the best establishments, however largely supplied with apparatus, can dispense with them even as convenient adjuncts.

From the Independent (N.Y.)

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